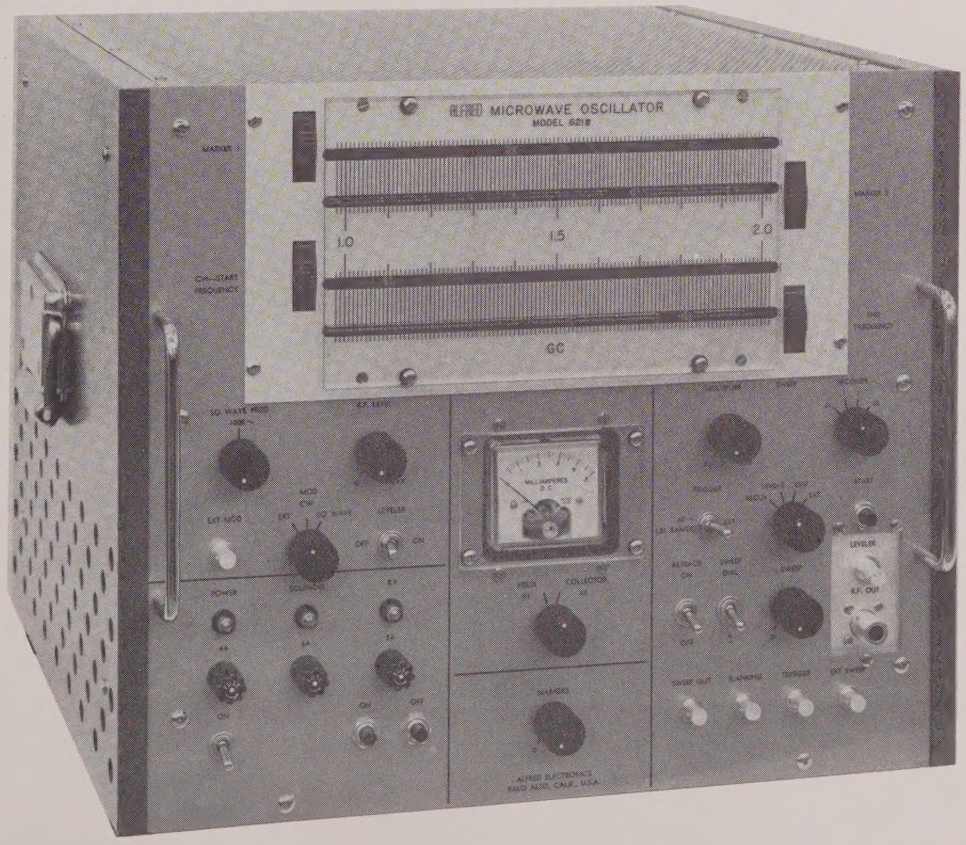
ALFRED ELECTRONICS

Stanford Industrial Park Palo Alto, California

MICROWAVE OSCILLATOR
Model 625B , Serial No. 513



ADDENDUM SHEET

Model 620B

Date	Change No.	Effective S/N	Description
3-1-62	10919	441	R31, 3.0Ω, ww added in series with V-7 filament.
3-19-62	10932	450	R31 changed to 2.4Ω, 5%, 1W
3-27-62	10937	520	Change C51 (50μf, 150V) to C51A (100μf, 200V) Change C52 (150μf, 150V) to C51B (100μf, 200V)
		501	Add B-1 Venturi Fan
3-29-62	10941	461	Change C-57 to 1.5 pf
5-7-62	10961	500	R72 changed to 15K, 10%, 1/2W; was 10K
5-14-62	10966	540	6.3 tap added between U and U^1 of T2 for parallel operation of V21, V22 filaments. R256 changed to 10K; was 5K.
5-18-62	10970	518	R70 changed to 270K, 1%, 1W; was 250K, 1%, 1W

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MICROWAVE OSCILLATOR
MODEL 625B

SPECIFICATIONS

Model 625B:	RF output may be unleveled or leveled with external accessory RF sampling components. Leveled specifications stated below can be met when sampling components are used.
Frequency Range:	12.4 to 18 Gc Continuously adjustable over entire range with direct calibrated dial, 1% accuracy.
Remote Frequency Control:	Rear terminals provide connection for external 100 K voltage divider or potentiometer to vary frequency over entire range.
RF Power:	At least 10 mw. Adjustable from zero to maximum.
Leveled Power Variation:	Flatness across the frequency range depends only upon transfer characteristics of the sampling components used. Flatness is independent of RF power setting.
Residual AM:	Side band power 40 db below RF rated output.
Residual FM:	Peak deviation less than 0.001% of highest frequency.
Drift:	±0.01% of highest frequency, per hour after warmup for ±5° C ambient change.
Frequency Markers:	Two markers adjustable over entire frequency range with calibrated dial, 1% accuracy. RF output reduced during marker.
Width:	0.5% of total range.
RF Reduction:	0 to 15%, leveled. 0 to approximately 10%, unleveled.
RF Connector:	"P" Band Flange UG-419/U
VSWR:	2.5:1 maximum

Frequency Sweep

Sweep Selector: Panel switch selects: Recurrent Sweep, Single Sweep, CW or External Sweep.

Width:

A. Continuously adjustable from 0 to any part of the entire frequency range. Sweep starts from CW value, increases in frequency to end value set on dial.

B. Symmetrical Sweep: 0 to ±5% of frequency range, centered about CW frequency.

Time: 100 to .01 seconds, selected with panel switch for 10, 1, .1, or .01 seconds, and X1, to X10 continuous vernier multiplier control. Independent of RF frequency sweep range.

Single Sweep Control: Panel switch selects single sweep triggering by: Panel "Start" button, External positive going signal 20 volts or greater to panel BNC connector, or Line frequency internal signal (.01 second sweep range only).

RF Blanking: Panel switch selects RF On or Off during retrace.

Monitor Output: Sweep Out, positive linear sawtooth, 45 volts peak during frequency sweep. Load 1 ma maximum.
Blanking Out -75 volts during retrace. Load 4 ma maximum.
Panel BNC connectors.

External: 200 volts gives full sweep width.
Negative voltage increases frequency from CW value.
DC to approximately 10 kc response.
Input impedance, 2 megohms shunted by approximately 50 mmfd.
Panel BNC connector.

Amplitude Modulation

Modulation Selector: Panel switch selects: CW, Square wave or External.

Internal Square Wave: RF output alternates from 0 to unmodulated value.
Frequency 800 to 1200 cps set by panel control.
Symmetry ±5%.

Rise and Fall Time: Less than 10 μsec, leveled.
Less than 1 μsec, unleveled.

External:	15 volt negative going signal varies RF output from maximum to 0. Input impedance, 500 K shunted by 20 mmfd. Panel BNC connector.
Rise and Fall Time:	1 to 10 μsec, leveled. Less than .5 μsec, unleveled.

Leveler Input (Model 620B only)

Polarity:	Negative
Voltage:	-50 to -120 mv required at rated RF output
Impedance:	Approximately 2.5 K shunted by 130 mmfd.
Power Switching:	Separate power and RF "On - Off" switches.
Metering:	BWO helix or collector current, 2" meter.
Protection:	Resistors connected across all high voltage capacitors to assure discharge upon removal of power. Helix overcurrent relay turns off BWO tube electrode voltage if safe helix current is exceeded.
Fusing:	Separate fuses for solenoid, low and high voltage supplies.
Power Input:	105 to 125 volts, 60 cps, approximately 850 VA.
Physical:	Bench or standard 19" rack. Removable handle sides permit rack installation. Height: 15 3/4" Width: 19" Depth: 15 1/2" behind panel, 17" overall.
Finish:	Panel: Grey hammertone. Sides: Dark metallic grey. Top: Light metallic grey.
Weight:	113 pounds.

SECTION 1 - GENERAL

1-1 DESCRIPTION

The ALFRED 620B series Microwave Oscillator is a compact, general purpose wide band signal source, utilizing a voltage tuned Backward Wave Oscillator tube and low drift, precisely regulated power supplies. It provides an output RF signal which may be either a single, stable frequency, manually adjustable to any value in the range, or electronically varied in frequency over all or any part of the band. The output frequency may be varied in proportion to an external voltage, or linearly with time over intervals from .01 to 100 seconds by an internal sawtooth generator. In addition, the 620B provides a set of terminals so that a potentiometer may be connected to permit remote frequency control or programming. The internal sweep may be single or recurrent. Single sweep may be triggered by panel push button, external signal, or an internal power line frequency source.

When the internal electronic sweep is used, a positive going sweep voltage proportional to frequency is provided on a panel connector. This sweep has a peak amplitude of 45 volts for X-axis drive of oscilloscopes or recorders. During the flyback interval, a negative pulse of approximately 75 volts is also brought out for oscilloscope blanking or pen control on recorders. A panel switch selects RF "on" or "off" during sweep flyback.

The 620B provides two frequency markers which can be manually adjusted by means of pointers and a calibrated frequency dial. The markers reduce the RF level by an amount adjustable from 0 to about 15%, giving a presentation similar to that obtained by the use of a wavemeter. Markers thus appear to be short triangular pulses with a width at their base of 0.5% of the total frequency range.

The RF signal from the oscillator may be selected by a panel switch to be CW, or amplitude modulated by either an internal 800 to 1200 cps square wave generator or an external signal. Frequency variation from amplitude changes is held extremely low by taking advantage of the compensation which occurs when modulation is applied to the BWO cathode. RF leveling is provided internally in the 620BK units to hold RF output changes with frequency to a minimum. Circuitry is provided in 620B units so that leveling may be achieved using external RF sampling components.

A large direct reading slide-rule dial calibrated to 1% accuracy, provides an easily legible presentation of CW frequency, sweep start and end frequencies, and marker frequencies. A panel meter monitors oscillator tube currents during normal operation or adjustment. The Backward Wave Oscillator tube requires no RF adjustment, is encapsulated for protection, and is easily replaced. Protective circuits prevent damage to the BWO tube during alignment and from most component failures.

The instrument is supplied normally, with sheet metal sides with handles, making it suitable for semi-portable or bench use. However, simply by removing the sides the instrument may be rack mounted.

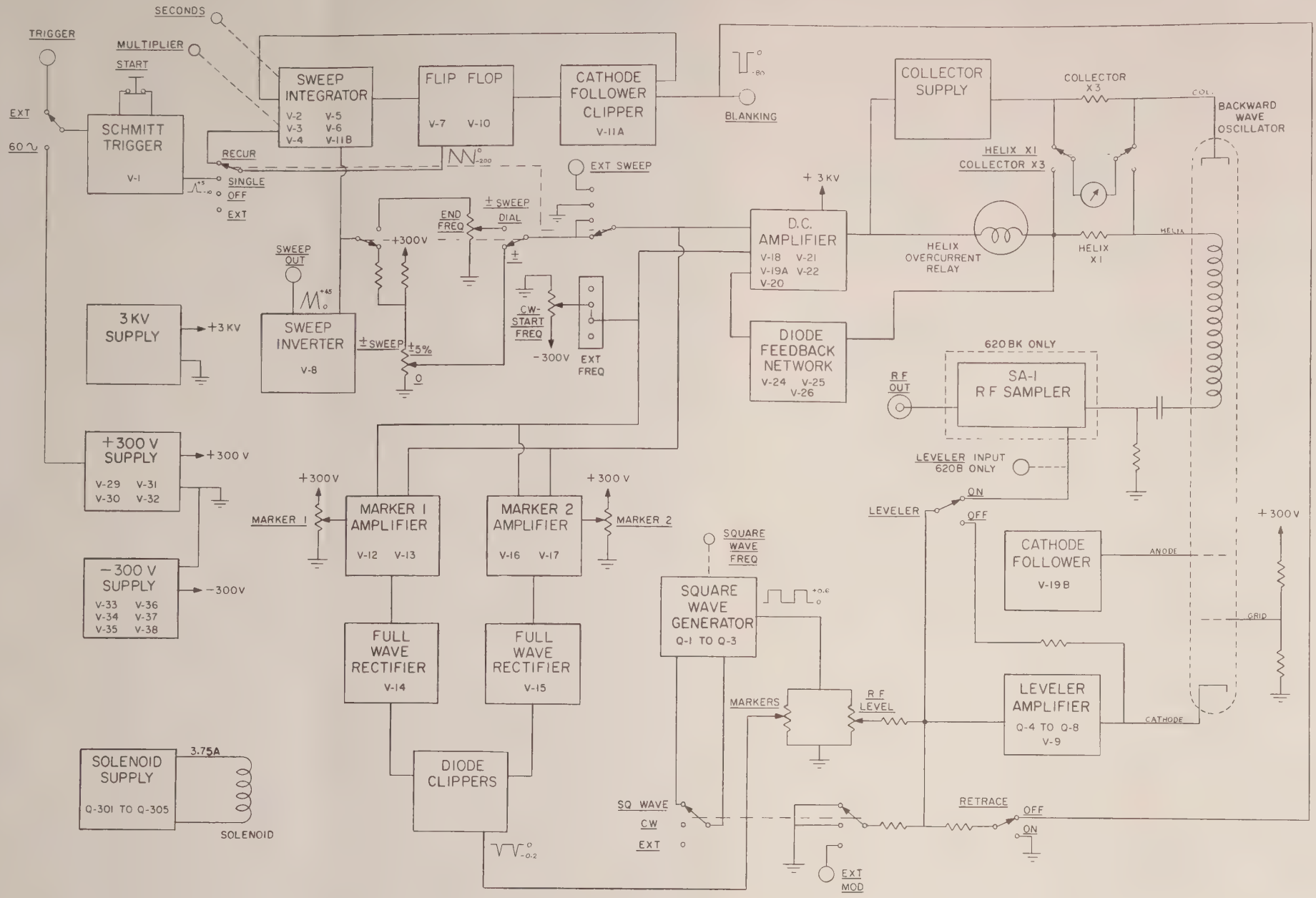


FIGURE NO. 2-1 BLOCK DIAGRAM 620 B SERIES 900447 C

SECTION 2 - THEORY OF OPERATION

2-1 GENERAL

The Model 620B series Microwave Oscillator consists essentially of a Backward Wave Oscillator tube which produces the RF output signal and a group of extremely stable power supplies to operate the tube and its focusing electromagnet. A block diagram for the instrument is shown in Figure 2-1.

2-2 THE BACKWARD WAVE OSCILLATOR TUBE

Since the radio frequency signal from the instrument is generated by a Backward Wave Oscillator tube, an understanding of its characteristics will help clarify the purpose and function of the various circuits. The BWO tube contains an electron gun which produces and forms an electron beam that travels axially through a long slender coil or helix to a metal collector electrode as indicated in Figure 2-2. Surrounding the tube is an electromagnet which produces a strong axial field. The diameter of the beam is carefully determined by cathode size and focusing electrodes so that with the aid of a magnetic field, most electrons may pass very close to, but do not contact the helix inside surfaces. To assure arrival of the beam at the collector the tube is mechanically positioned so the helix and magnetic field axes are parallel.

Interaction of fields in the electron stream and the helix is such that a minor disturbance will start RF oscillations. A wave develops on the helix which increases in amplitude from the collector to the gun end. The electron beam is bunched by the fields from this wave and thereby provides increased energy or effective gain in the direction of flow from the gun toward the collector end of the tube.

In simplified terms the RF field on a given turn of the helix, velocity modulates the electrons so that upon arrival of the electrons at the next turn, some bunching has taken place. The beam returns RF energy to this second turn which upon receipt will travel back along the helix towards the gun to the earlier turn. The original bunching power in the first turn is thus replaced and the process continues, provided the total phase delay in the beam and helix is correct for positive feedback. Actually this interaction and feedback is continuously distributed all along the beam and the helix.

Since the phase on the helix varies with the frequency, the frequency at which oscillations are sustained automatically becomes that which gives correct phase. By changing the velocity of the electrons, the time delay or phase shift in the beam is altered and thus the total loop phase is changed. The frequency therefore, readjusts itself so that the new helix phase just corrects for the change in beam phase. Electron velocity is controlled by the accelerating potential, namely, the helix to cathode voltage. Thus the output frequency is determined by the helix voltage which is operated in the range of 150 to 2400 volts positive with respect to the cathode.

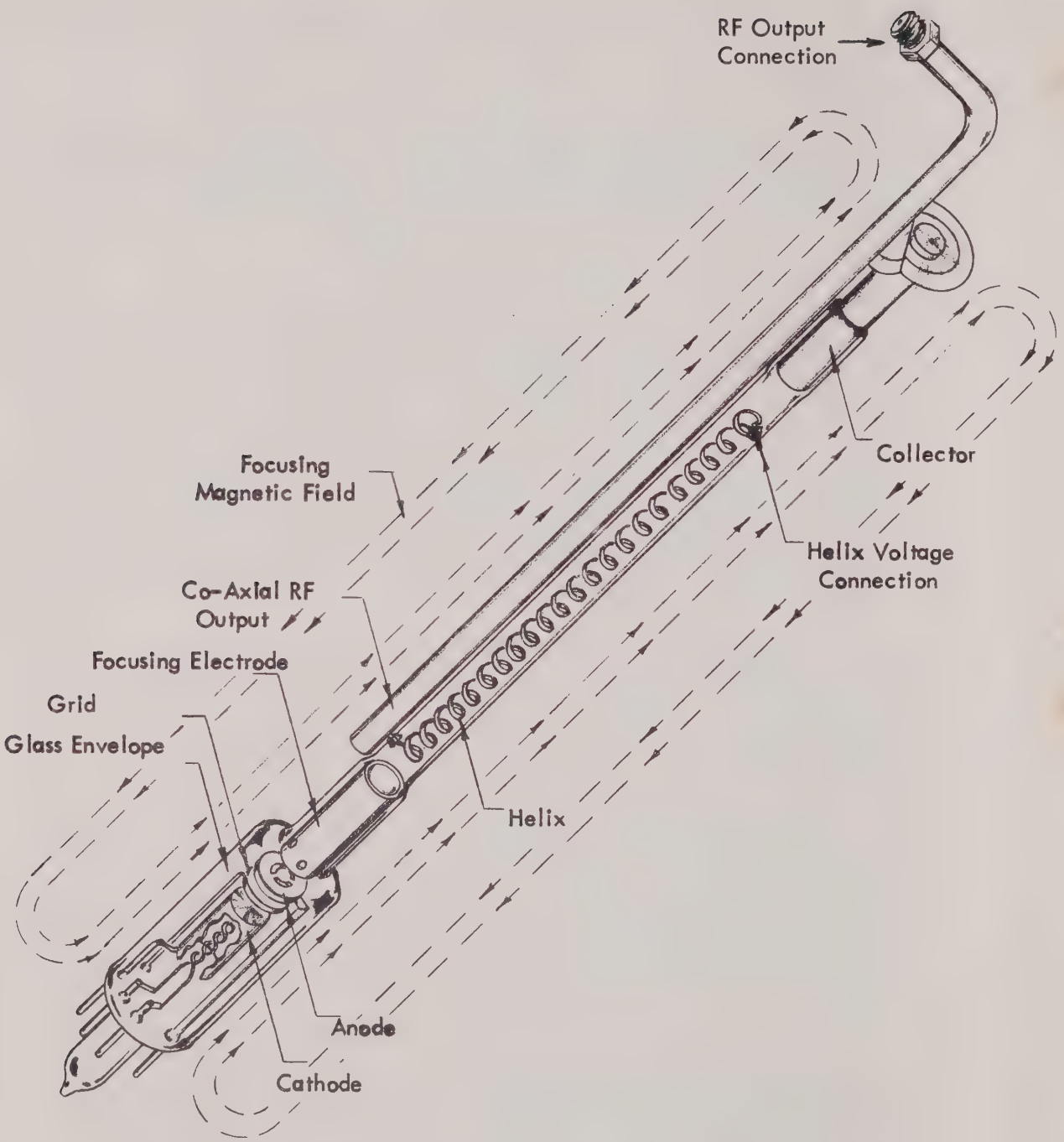
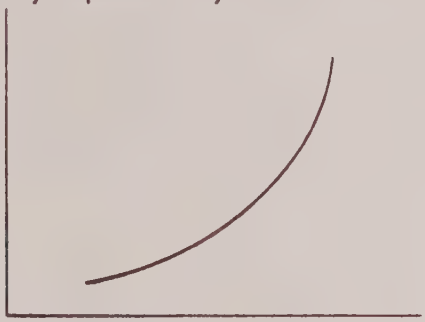


Figure 2-2
Backward Wave Oscillator Tube

The oscillator frequency increases with helix voltage very closely to a logarithmic relation as indicated in Figure 2-3. Thus to obtain a linear frequency variation, helix voltage must vary exponentially.



$V_{helix} \approx K_1 e^{K_2 f}$

$f \approx K_3 \log_e V_{helix}$

K_1, K_2, K_3 constants of the BWO tube

Figure 2-3

The collector electrode receives the beam after it leaves the helix and is operated approximately 51 volts above the helix potential so that any secondary electrons produced return to the collector. If they were to drift back into the helix area, the slight change in beam density would affect frequency and helix current would not be a true measure of the forward electron interception.

Other factors which affect frequency, but by much smaller amounts, are the magnetic field, slight mechanical deformation of the helix structure, temperature changes in the magnet winding, and beam current density. A current regulated source with low ripple for the focusing magnet reduces frequency errors from magnetic field changes to less than .001%. A large capacity blower holds temperature rise of the solenoid and BWO tube to less than 30° C which makes negligible any frequency drift from thermal changes.

The electron gun contains a heated cathode and two aperature disc type control electrodes which help to form the beam and also control beam density. The disc nearest the cathode is termed the grid and the other more remote electrode is called the anode. Their influence on the beam current is very similar to that of the control and screen grids respectively in a conventional tetrode. The RF output from the BWO tube is proportional to beam current. Normal beam current and hence rated RF output results with the grid at 0 volts and the anode about +150 volts, both relative to cathode. Reducing the grid to -25 volts or the anode to 0 will cut off the beam and RF output. Turning the beam from off to on very rapidly by applying a voltage to either the grid or anode, will cause the RF oscillations to build up almost exponentially with a time constant of $\frac{Q}{\pi f}$, where Q is the effective tuned circuit figure of merit. For stable operation, the Q of the BWO tube should be as high as possible. In practice, it is approximately 1000. Thus if the RF envelope rise time is defined as 4 time constants, at 3 Gc the rise

time is equal to $\frac{4\,Q}{\pi f} = \frac{4 \times 10^3}{\pi \times 3 \times 10^9} \approx .4$ microsecond. By proper design, the pulsed rise and fall times of the BWO tubes used in 620B Series Oscillators is held to less than .5 microsecond.

Power level change per volt of grid or anode voltage is greatest at the high end of the frequency range. This results primarily from the hole in disc design of the grid and anode electrodes. The electric fields from the discs have the greatest influence on the outer electrons of the beam. In the helix region the RF fields penetrate only the outer portions of the beam at the high end of the band. Therefore, as the anode or grid voltage is made more negative, the outer portion of the beam is cut off first, removing the electrons which interact with the RF fields at the high end of the band. Since RF field penetration is greater at lower frequencies the remaining inner electrons will still produce enough interaction for oscillations until the beam is completely cut off. Because of the variation of control sensitivity with frequency, either anode or grid control will cause output at the high end of the band to go to zero first.

2-3 HELIX SUPPLY

The helix supply consists of two major portions, a Sweep Generator followed by a non-linear Power Amplifier. The sweep generator produces an extremely linear sawtooth voltage of accurately controlled time and amplitude. The power amplifier is an extremely stable non-linear DC feedback amplifier.

A linearly varying voltage applied to the amplifier input, gives approximately an exponential output, which in turn is applied to the helix of the BWO tube to produce a linearly varying frequency. For manual frequency control, the input voltage is obtained from a linear 10 turn potentiometer across a stable DC supply, so frequency is exactly proportional to shaft rotation. In like manner the sawtooth voltage is also connected to a 10 turn linear potentiometer. By summing the DC and sawtooth voltages from the potentiometers, the frequency will sweep from the manually set value, over a range determined by the amplitude of the sawtooth voltage. In addition, the sawtooth signal may be selected to come from a potentiometer which forms a part of an attenuator to give 0 to 10% of the total sweep voltage. A DC bias is also added so that the sawtooth voltage will be symmetrical about zero and of magnitude ± 5%. By summing this voltage with the voltage from the CW frequency control, one obtains a sweep across a narrow frequency band centered at the CW frequency setting.

2-4 SWEEP GENERATOR

In the following text, all front panel control titles are capitalized and underlined while chassis controls are indicated by capital letters only.

Refer to Figure 4-3 for the circuitry involved in the sweep generator section of

the instrument. The sweep generator consists of a high gain DC amplifier with capacitive feedback and a bi-stable multivibrator which produces a rectangular waveform that is applied to the amplifier input. Figure 2-4 illustrates the simplified arrangement. The amplifier and its feedback capacitor connections comprise a Miller integrator circuit.

The amplifier A has zero output with zero input. Due to its high gain, any input E_1 will cause a current I_1 in R and a feedback current through C to be of a magnitude and direction to cancel I_1. This self balancing action tends to keep the input of A at zero volts. The charging current through C therefore is equal to $\frac{E_1}{R}$, a constant. Therefore, I_2 is constant also and equal to I_1. The voltage across C becomes $\frac{I_2 t}{C} = \frac{E_1 t}{RC}$. Since the input to A tends to remain at zero, the output E_o is equal to the voltage across C or $\frac{E_1 t}{RC}$, a constant multiplied by time t. Thus a linearly changing output voltage is obtained. The slope of the output wave can be varied by changing E_1, R or C.

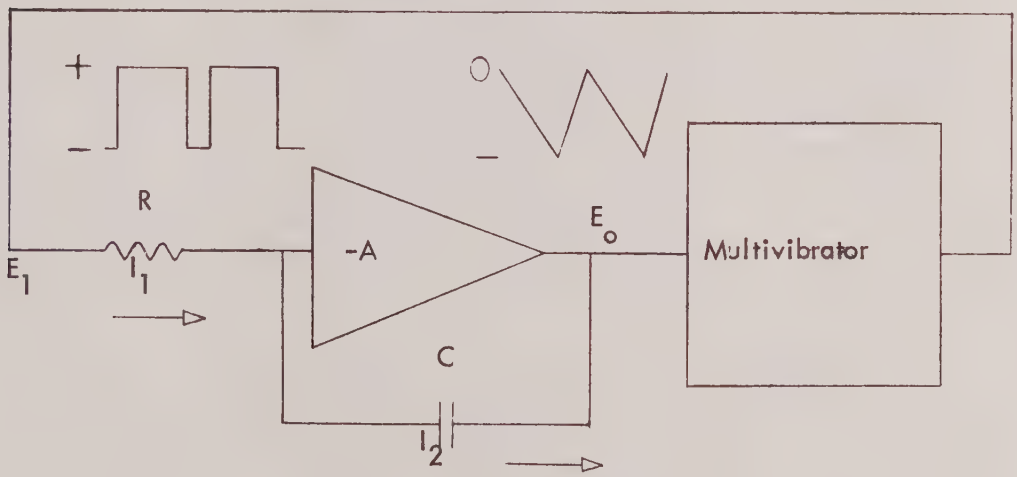


Figure 2-4

In the actual circuit, R is obtained from the resistor network of R1 through R5; C is selected by the sweep SECONDS switch SW1. The rectangular wave input (SW2 on RECUR) is from the multivibrator circuit of V10 and its associated components. The amplifier .. composed of tubes V2, V3, V4, V5, V6 and V11B. The output E_o is taken at pin 2 of VR tube V6, and the input to the amplifier is made at the grid of V2, pin 7.

In the amplifier, tube V2 is connected differentially to minimize drift. Tube V3B is connected as a cathode follower. VR tubes V4, V5, and V6 maintain the cathode of V3B at a fixed voltage of approximately 258 volts above the output

voltage E_o. This constant drop is used to determine the start and end voltage levels of the sweep. Tube V11B maintains essentially constant current through the cathode follower V3B and the regulator tubes V4, V5 and V6. To do this, the grid voltage of V11B is fixed and its cathode is self biased with resistor R58. The change in grid bias to hold the plate current constant for a plate voltage swing of 200 volts is only about 4 volts. The change in voltage across R58 therefore is small, making the plate current of V11B nearly constant.

The bi-stable multivibrator V10 produces a rectangular wave output. V10 is cross coupled, plate to grid with resistors and its cathodes are grounded. Thus V10A turn on occurs when its grid is near ground potential. The plate waveform of V10B is shifted in DC level and attenuated by R20 and R23 and fed to the grid of cathode follower V11A. The output from V11A cathode is clipped by diode V3A to produce the rectangular waveform required by the amplifier This produces the linearly varying sawtooth at the amplifier output. The external signals, required to switch the multivibrator, are derived from the sweep voltage levels by diodes V7A and V7B to determine the start and end of each sweep.

To understand the interaction between the multivibrator and the amplifier, assume that the SWEEP switch SW2 is in the RECUR position, that a retrace has just been completed, and a forward sweep is just starting. At this instant the multivibrator has just switched, and the following conditions exist. V10A has just received a positive input and is conducting heavily. V10B is cut off with its plate at +258 volts, causing cathode follower V11A to conduct heavily, setting its cathode at +40 volts. This +40 volts has just cut off V3A, removing a negative input to the amplifier. A positive 200 volts through the network of R1, R2, R3, R4 and R5, now drives the amplifier during the forward sweep. This positive input causes amplifier V2A plate, pin 6 to proceed linearly downward from approximately +258 volts. The cathode of V3B follows with essentially the same waveform and level.

The output E_o follows the cathode of V3B at a constant 258 volts more negative, producing the capacitor feedback current I_2 which balances the positive constant input current I_1 to maintain the input grid of V2A at a zero level.

The output voltage will continue to decrease linearly until the input to R5 is changed. This change is brought about by the action of diode V7A. Since V10B is cut off, the top of R12 is at +258 volts, and the slider of R13 is adjusted to about +58 volts in the divider network circuit of R12, R13, R14 and R15. When the cathode of V3B decreases from 258 volts to the value set by the slider of R13, V7A will conduct. Since VR tubes V4, V5 and V6 hold E_o to exactly 258 volts below the cathode of V3B, the point at which V7A conducts establishes the end value of the forward sweep, namely, -200 volts. When V7A conducts, the increase in current in R12 and R13 drops the grid voltage of V10A from about 0 to -1 or -2 volts, causing V10 to flip so that V10B is now conducting heavily.

Cathode follower V11A follows the plate of V10B so that its output switches from about +40 to -55 volts. Thus a step function of -55 volts is applied to R5 from a low impedance source consisting of V11A and diode V3A. This negative step input to V2A reverses the sweep output voltage at precisely -200 volts.

The sweep output voltage E_o will continue in a positive direction during the retrace interval until V10 is flipped again to its original condition and the input at R5 again becomes positive. This ends the retrace and is controlled by diode V7B. At the start of the retrace, the plate of V10B is down to about +75 volts and there is a large bias of -85 volts on the grid of V10A from the divider network of R12, R13, R14 and R15. The plate of V7B is a few volts below E_o and the cathode is tied to the V10A grid. As E_o increases towards zero, it will reach a value where V7B conducts. The grid voltage on V10A is now controlled by E_o through V7B. RECUR SW ZERO potentiometer R18 is adjusted so that when E_o reaches exactly zero volts, V7B will put a bias on V10A of such value that V10A starts to conduct. This will start the reversing action in the multivibrator and change the output of the cathode follower V11A from -55 volts back to the +40 volts. The switch from -55 volts to +40 volts cuts V3A off and a positive step input to the amplifier is again applied.

When the SWEEP switch SW2 is placed in SINGLE position, the sweep circuit action is the same as in the RECUR mode but the initiation or start of a forward sweep through V7B is now controlled by a pulse from the Schmitt trigger circuit V1 instead of being derived from the output E_o. At the same time the output, E_o, is connected to the input grid of V2A through diode V7C. With these connections, V7B now controls the start of the sweep instead of the zero level as it did in the RECUR mode, and V7C controls the voltage to zero between sweeps. The action of V7A in reversing the forward sweep at -200 volts is the same as for RECUR mode.

When the retrace portion of the sweep reaches zero volts, V7C will conduct. No further rise can occur since all of the output E_o, is now coupled back to the grid of V2A through the low conducting impedance of V7C. The amplifier gain is thus reduced to approximately zero. V7C can be made to conduct with its plate and E_o at precisely zero volts by adjustment of SINGLE SW ZERO potentiometer R9. This will change the bias on V2A until it is a negative value exactly equal to the drop across V7C. The output, E_o, will remain at zero volts as long as there is a negative input voltage to the amplifier at R5, and this condition will exist until the multivibrator is made to reverse. V10A is cut off with its grid held to a small negative value set by the -10 volts from the junction of R54 and R55 acting through diode V7B. Thus, the multivibrator is now receptive only to a positive pulse. A positive signal from the Schmitt trigger is transmitted by V7B to the grid of V10A to reverse the multivibrator. This reversal changes the input to the sweep amplifier from negative to positive, and a forward sweep is started. During the forward sweep interval, any subsequent positive trigger will have no effect since V10A is

now conducting heavily and any negative trigger would not be transmitted by V7B. Since V10A is cut off during retrace interval, any negative trigger will have no effect, but any positive pulse before the retrace is completed will cause the multivibrator to flip and initiate the forward sweep before the retrace interval is completed. To prevent a positive pulse from starting another sweep during the retrace interval, the total sweep interval should be less than the period of the triggering waveform. In general, since maximum retrace time is about 18 percent of the total sweep period, sweep SECONDS and MULTIPLIER may be set for sweep periods up to four times trigger period and satisfactory sweeps will occur. Thus, when TRIGGER switch SW4 is in 60 ~ position sweep SECONDS should always be on .01 position. The 60 cycle trigger is not supplied on the other sweep SECONDS ranges to prevent triggering during retrace.

A single positive trigger pulse can be applied to multivibrator V10 to start a single sweep by pressing START switch SW5. To prevent repetitive triggering at 60 cps on the 0.01 range, trigger switch SW4 should be placed on EXT position. Also, the sweep may be initiated by an external voltage connected to TRIGGER jack S1 with TRIGGER switch SW4 placed in EXT position.

The sweep time is only a function of the slope of the output wave shape, since the output voltage limits are fixed at zero and -200 volts. Slope can be varied by changing input voltage E_1, R or C. C is changed in decade amounts by SECONDS switch SW1 and R is varied by MULTIPLIER potentiometer R3. To make the retrace time less than the forward sweep time, R is made appropriately smaller. The shortest practical value of retrace time is limited by the characteristics of the BWO tube to about 1.8 milliseconds. Thus, when sweep SECONDS switch SW3 is on the .01 position and R3 is at X1 (minimum), the total sweep is 10 ms and the forward portion of the total sweep is 8.2 ms. The MULTIPLIER R3 in its maximum resistance position, increases the forward sweep time by approximately a factor of 10. It has no effect on the retrace sweep time, so the percent of total time taken by the retrace is progressively smaller as R3 is increased. The ratio of retrace to forward trace time remains the same when the sweep time is changed by the sweep SECONDS switch SW1.

When the SWEEP switch SW2 is in the OFF position, the sweep output E_o is shorted to the input of V2A through V7C thus reducing the output E_o to zero. The switch in this position also grounds the sweep input to the non-linear power amplifier.

When SWEEP switch SW2 is in the EXT position, the linear sweep circuit is deactivated in the same manner as in the OFF position except the sweep input of the non-linear power amplifier is connected to EXT SWEEP jack S3, to permit application of external sweep voltages.

2-5 SCHMITT TRIGGER

Refer to Figure 4-4 for the Schmitt trigger circuitry.

With TRIGGER switch SW4 on EXT position, any arbitrary positive going waveform of 20 volts or more will operate the Schmitt trigger to produce a positive pulse at the junction of R54 and R55. Depressing START switch SW5 also produces a pulse at this point. A positive pulse here will flip V10 to initiate a sweep. A 60 cycle pulse is obtained by placing TRIGGER switch SW4 on 60 ~ and when sweep SECONDS switch is on .01 range. SW1 disconnects 60 cycle triggering on all other ranges.

With TRIGGER switch SW4 on EXT, V1B is conducting heavily, producing a cathode voltage of about +15 volts on R48 to cut off V1A. The right side plate, pin 6, is at about +50 volts. The voltage at the junction of R54 and R55 is about -10 volts and capacitors C18 and C19 are thus charged to 60 volts. When the START switch SW5 is depressed, V1B is immediately cut off and the capacitors now charge to 310 volts. Since the voltage across the capacitors cannot change instantaneously, the 250 volt change will appear across resistors R52 and R54. The portion of this change at the junction of R54 and R55 is determined by the ratio of R54 to R52 and is such that a pulse approximately +9 volts in amplitude is obtained when there is no output load. The pulse has a sharp, triangular shape determined by the short time constant of the charging circuit. R54 and R55 set the voltage between pulses at -10 volts to assure that V10A remains cut off.

When the trigger output is used to control the sweep circuit by placing SWEEP switch SW2 in the SINGLE position, the effective charging resistance is lowered when V10A conducts. This results from the shunting effect of diode V7B resistance and V10A grid-to-cathode impedance across R54. This reduction in resistance lowers the positive portion of the pulse to about +2 volts.

When switch SW5 is released, V1B will again conduct and the action will reverse, producing a negative pulse of about -25 volts.

A positive pulse can also be generated by a positive input of about 20 volts at TRIGGER input connector J1 with TRIGGER switch SW4 on EXT. This causes V1A to conduct. The voltage drop across R49 causes V1B to conduct less which decreases the cathode voltage at R48 to cause V1A to conduct still more. This positive feedback process turns V1A to full on and V1B to full off instantaneously, thereby producing a positive output in the same manner as when START switch SW5 is depressed.

When TRIGGER switch SW4 is on 60 ~ and sweep SECONDS switch is on .01 range, an internal 60 cycle voltage of approximately 28 volts peak is applied to the input of the trigger circuit. When the input reaches a value sufficient to turn V1A on, a positive pulse is generated at the trigger circuit output.

2-6 SWEEP OUT

The internal sweep waveform is inverted, reduced in amplitude, and brought out as a positive sawtooth at the panel SWEEP OUT connector. The sweep sawtooth is applied through R63 to the grid of amplifier tube V8. Negative feedback through R64 determines the gain of the amplifier so the output is approximately 45 volts peak. The two halves of V8 are connected differentially to minimize drift.

2-7 BLANKING PULSE

A voltage of -80 volts appears at BLANKING jack J4 during sweep retrace or between single sweeps. This voltage is obtained from the junction of R24, R25 and R26 at the output of cathode follower V11A. CR1 is a shunt diode clipper to hold output at zero during the sweep interval. The blanking pulse may also be fed to the leveler amplifier to cut off the BWO by placing RETRACE switch SW10 in the OFF position. When SWEEP switch SW2B-1 is in EXT or OFF position, negative blanking voltage is eliminated by disconnecting R25 and R26 from the -300 volt supply.

2-8 NON-LINEAR POWER AMPLIFIER

A linearly varying voltage applied to the input of the non-linear power amplifier produces an exponentially varying output voltage. When this output is applied to the helix of the backward wave oscillator tube, the RF frequency changes linearly. See Figure 4-5 for the circuitry of the non-linear amplifier portion of the instrument.

The non-linear amplifier is a high gain DC amplifier with negative feedback as shown in Figure 2-5.

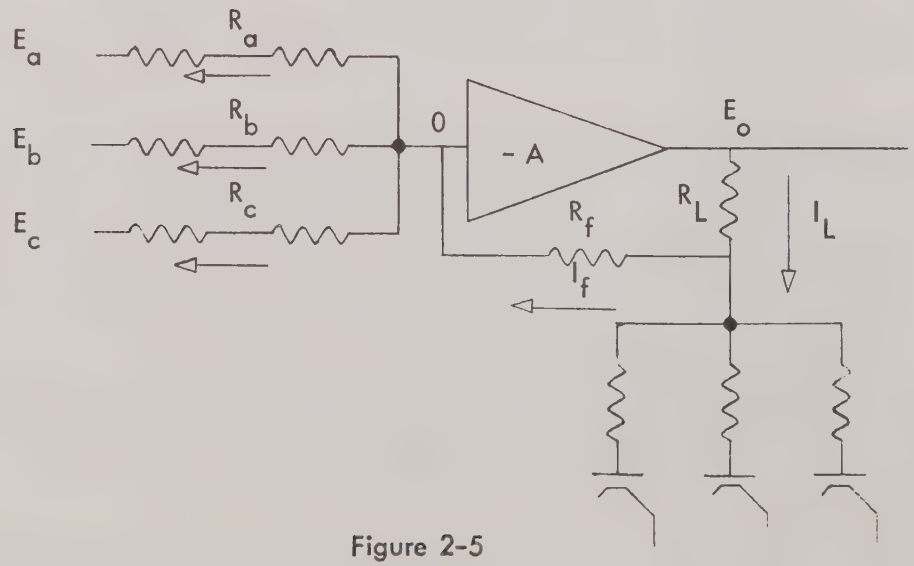


Figure 2-5

Input voltage E_a is set by the panel CW-START FREQUENCY potentiometer R73. It may also be obtained from an external voltage divider connected to EXT FREQ terminal strip TB1. E_b is the linearly varying sweep voltage from the sweep circuit with amplitude adjusted by the panel END FREQUENCY potentiometer R66, or the narrow sweep voltage from potentiometer R72. E_c is a preset voltage determined by START FREQ CALIB potentiometer R133.

The self-balancing action of the amplifier will provide an output E_o of such magnitude that the feedback current I_f is equal and opposite to the sum of the currents produced by E_a, E_b and E_c through resistors R_a, R_b and R_c.

E_o is made an exponential function of the input by progressively shunting the feedback circuit with a series of diodes that are biased to conduct consecutively with increasing E_o. Since the feedback current I_f must balance the sum of the input currents, the output voltage E_o must increase to supply both I_f and the currents required by the diodes. By controlling the conduction currents of the diodes with plate resistors R136 through R146, the proper increments in the slope of E_o can be obtained. Diode bias is provided by divider resistors R173 through R183.

R_a is resistor string R74 through R80, R_b is resistor string R83 through R88, R_c is R134, R_f is feedback resistor R135 and R_L is resistor string R90 through R96. The diodes are tubes V24, V25 and V26 which have three diodes in each envelope.

The amplifier A is composed of tubes V18, V19, V20, V21 and V22 with their associated circuitry. V18A is connected to V19A to form a differential amplifier. The grid of V18A is the amplifier input and the grid of V19A is connected to ground as reference. Connected in this manner, only the difference between the input at the grid of V18A and the input at the grid of V19A (which in this case is at ground potential) is amplified, to produce a push-pull output at their plates. Any drift in level, due to heater voltage variation, for example, is minimized by the differential amplifier. To utilize both outputs of the differential amplifier in driving amplifier tube V20, the output from the plate of V19A is connected directly to the grid of V20 and the other output from V18A is connected to the cathode through cathode follower V18B. By employing V18B as a cathode follower, the load for V18A is a high impedance grid, the same as V19A. At the same time, both proper polarity and load for the cathode input to V20 is also obtained. Except for some loss in gain of the output from plate of V18A through cathode follower V18B, the full push-pull output of the differential amplifier is effectively applied to grid and cathode of amplifier V20. The plate output of V20 is used to drive tubes V21 and V22.

Tubes V21 and V22 are paralleled cathode followers which provide voltage in the range of 150 to 2400 volts through the overcurrent relay K2 to the helix

of the BWO tube. Grid control of V21 and V22 is from the plate of V20 through the load resistors R37 through R40. The screen grid supply for V21 and V22 is obtained by charging C11 through rectifier CR2 and is regulated to +51 volts by zener diode ZD1. The grid swing on V21 and V22 required to produce the wide output voltage range is small. Since the voltage across R37 through R40 is only the sum of the constant screen voltage supply and V21 and V22 grid swing, the current variation is small. A pentode is used for V20 to permit a wide voltage swing with a small plate current variation.

The complete amplifier action is briefly summarized as follows: The summed input, which may be either a fixed or varying voltage is differentially amplified to provide a push-pull input to V20. The plate variation in V20 is used as the grid input to cathode followers V21 and V22. Their cathode voltage moves up or down as required to furnish both the balancing feedback current to the input and the diode shunting current. The output E_o is made exponentially proportional to the input by controlling the diode currents.

With E_a and E_b set to zero and E_c properly adjusted with the START FREQ CALIB potentiometer R133, the output E_o of the amplifier provides the helix of the BWO with the exact voltage required at the lowest frequency. Depending upon the BWO tube, this voltage may be 150 to 550 volts. When sawtooth voltage E_b is zero, the output frequency will be determined by E_a as obtained from the setting of CW-START FREQUENCY potentiometer R73 or an external voltage divider connected to EXT FREQ terminals TB1. In addition, by applying the linear sweep voltage E_b from END FREQUENCY potentiometer R66, the instrument will produce a linearly varying frequency, sweeping the range from the start value as set by R73 to the end frequency as set by R66.

The CW-START FREQUENCY potentiometer R73 and the END FREQUENCY potentiometer R66 are mechanically connected so that the sum of the voltages can never exceed the value required for maximum frequency output of the instrument. It is also noted that the potentiometers are mechanically linked so that the end frequency setting may not be less than the start frequency setting.

2-9 HELIX OVERCURRENT RELAY

The maximum safe value of BWO tube helix current is about 3 ma. To provide protection with a safety margin, overcurrent relay K2 is employed to trip at approximately 3 ma. The current in R90 through R96 varies from about .2 to .9 ma over the output voltage range. The helix current trip therefore varies from about 3.0 ma at the low end, to about 3.7 ma at the high end.

When relay K2 trips, it shorts out the coil of K1 opening its contacts which disconnects the primary input to high voltage power transformer T1 and the +300 plate voltage supply to V18B and V19B. V18B is cut off to prevent its overloading when high voltage is removed from V20. V19B is also cut off to remove anode voltage from the BWO tube.

Meter M1 is a 0 - 1 ma movement with 5 ma scale. Shunt R103 is used to change the meter range when measuring helix current and shunt R101 is used when measuring collector current. The meter switch position may be changed during operation without danger from transient effects since the shunts remain connected to the load during the switching action.

2-10 COLLECTOR SUPPLY

The voltage to the BWO collector electrode is maintained at essentially a constant value above the helix voltage. This is accomplished by using the 51 volt screen grid supply for V21 and V22 consisting of C11, rectifier CR2 and zener diode ZD1. The voltage from the BWO helix to collector is thus the constant 51 volts across V22 plus the small drop in the helix overcurrent relay K2.

2-11 ANODE SUPPLY

V19B is a cathode follower with adjustable grid voltage from potentiometer R97 to provide a fixed source of positive voltage from about 25 to 250 volts for the BWO anode. The plate and grid voltage for V19B is supplied through relay K1 and is disconnected when RF power is removed.

2-12 LEVELER AND AMPLITUDE MODULATION

All 620B series instruments have the electronic circuitry required for feedback leveling of the RF output. Model 620BK units have, in addition, the requisite RF sampling components internally mounted. Model 620B units have a panel connection for leveler input to permit connection of external accessory RF sampling components to effect leveling. Regardless of whether the components are internal or external the operation of the leveler is the same.

See Figure 4-6 for the leveler circuitry. The action of the leveler is similar to most feedback control systems. The output is sampled, the sample compared to a fixed reference to produce an error signal, and the error signal amplified and applied to the control device. It is important that the BWO output be unaffected by the equipment used for loads, thus a directional coupler DC1 is used to sample

the RF output from the oscillator. The RF sample is detected by means of a crystal detector CR22 to obtain a DC voltage proportional to RF power since the crystal has approximately a square law relation between RF voltage in and DC voltage out. This voltage from the crystal is fed into a summing amplifier, together with a reference voltage of opposite polarity. If there is a difference (or error) between the two signals, the difference will be amplified and applied to the cathode of the BWO; thus automatically controlling the beam current and adjusting the RF output for minimum error.

When LEVELER switch SW12 is in ON position, the output of the crystal CR22 is applied to the summing junction of the amplifier through potentiometer R256 (RF MAX) which is set to establish the RF output at rated value when the RF LEVEL is set to MAX. The reference voltage is taken from the RF LEVEL control and applied to the summing junction of the amplifier through R216. The RF level is set by changing the reference. The action of the feedback from the crystal is to tend to match the reference; thus the signal will follow the RF LEVEL setting. The summing junction is connected to the base of Q4 to form the input to the amplifier. It will be noted that any current or voltage applied here will be indistinguishable from any other, thus drift in voltage or current in the transistor is equivalent to a change in reference, and will result in a change in RF level. Drift in the input has been minimized by using a differential amplifier and carefully selecting the voltages, currents, and temperature coefficients of components. The ZERO adjustment, R221, is set to supply the required base current to balance the amplifier. Temperature compensating resistor R219 automatically adjusts bias to compensate for changing base current requirements with temperature. Transistors Q4, Q5, Q6, Q7 and Q8 comprise the leveler amplifier. V9A is a cathode follower to supply +56 volts to the top end of R230. The LIMIT potentiometer sets the output voltage range of the leveler to correspond to the grid sensitivity of the specific BWO tube used in the unit. V9B is a cathode follower used to drive the BWO tube cathode.

When MOD switch is in the SQ WAVE position, an internal square wave generator provides the signal for internal modulation. Transistors Q1 and Q2 and their associated circuitry comprise a free-running multivibrator which produces a square wave of voltage across R208. When the MOD switch is in EXT or CW positions, R203 is disconnected so that Q2 conducts continuously. The circuits are heavily degenerated to make the frequency and symmetry independent of the transistors used. Frequency is controlled by changing the charging currents to C43 and C44 by potentiometer R207. The signal from R208 is applied to Q3 through R209, turning Q3 alternately on and off. Whether Q3 is conducting or non-conducting, the RF level will be the value set by the RF LEVEL control, or it will be zero. Thus the action of the square wave modulation will be to periodically reduce the RF from its normal unmodulated level to zero.

In order to obtain amplitude modulation of the RF power, signal currents may be

applied to the summing junction and will act the same way as a change in reference current to change the RF level. Thus, for external modulation, a signal from the EXT MOD input BNC connector is applied to the summing junction through R217. Since approximately 25 microamperes are required to cut the RF off when RF LEVEL is set to maximum, and the input resistor is 499 K, 12.5 volts applied to the EXT MOD connector will turn the RF off. Similarly, internal square wave modulation is accomplished by applying a square wave of voltage to the RF LEVEL potentiometer, R215. Markers are also summed into the RF LEVEL control through MARKERS potentiometer R213. The result is a reduction in RF reference level when the markers occur. Retrace RF blanking is obtained by adding the blanking voltage from the sweep generator to the leveler amplifier through R218. When MOD switch is in EXT position, RF level can be remotely programmed or continuously varied during leveled or unleveled operation by applying a 0 to 12.5 volt DC signal to the EXT MOD connector.

If the LEVELER switch is turned OFF, as it must be for 620B units without accessory RF components, or when unleveled operation is desired, operation of the unit is changed somewhat. The leveler amplifier is still used as a summing amplifier. However, feedback current is now derived from a resistive divider comprised of R259, R258 and R257. This divider provides direct feedback from the output of the amplifier. Thus the RF level is controlled by the amplifier through the transfer characteristics of the BWO tube cathode. Conversely, with the leveler turned ON, the RF power is sampled and controlled directly, and is essentially independent of the characteristics of the BWO tube.

C45 and R228 provide control of the amplifier high frequency phase response to prevent oscillations when LEVELER switch is OFF since feedback in this case is around the amplifier itself. When LEVELER switch is ON R260, C56 and C55 are also added to stabilize the feedback loop which now includes the BWO and RF sampling components. C55 is made variable to adjust for stable operation with best transient response.

2-13 RETRACE CONTROL

With RETRACE switch SW10 in the OFF position, the negative blanking voltage is applied to the leveler amplifier input at R218. The leveler amplifier acts to reduce the RF to zero when -80 volts is applied here. Voltage to R218 is removed when RETRACE switch is OFF thereby eliminating blanking during sweep flyback.

2-14 MARKERS

The markers appear as short pulsed reductions of the RF output during sweep. To generate them, short video pulses are applied to the leveler amplifier through R213, R215, and R216. They are electronically derived from the internal sawtooth voltage used to drive the non-linear amplifier in producing the RF output. The markers are thus related to the RF through the transfer characteristics of the non-linear

amplifier. By obtaining the markers from the sawtooth voltage instead of the RF output, their circuitry is independent of the RF characteristics of the instrument, and can be used without change in the various models.

The generation of the two markers is accomplished by the circuitry shown in Figure 4-7. The operation is the same for both markers, so only Marker 1 which includes V13, V12 and V14 will be discussed.

Three inputs are summed through R115, R116 and R117 to provide the input to amplifier V13 (left side). Two of the inputs are seen to be the same as the inputs to the helix non-linear amplifier; namely, the voltage from the CW-START FREQUENCY control potentiometer and the linearly varying sweep voltage from the END FREQUENCY potentiometer. The third input is a positive voltage from MARKER 1 potentiometer R113. Thus, the resulting input is a sawtooth identical to the input of the non-linear amplifier except for DC level which depends upon the relative settings of CW-START and MARKER 1 potentiometers. Consequently, the marker is at all times synchronized with the sweep frequency. The voltage from R113 in adding to the sum of the voltages from the CW-START and END FREQUENCY potentiometers, determines the part of the sawtooth voltage which makes the summed input at V13 go through zero. When this occurs the circuit acts to produce a marker. For a marker to be generated, R113 has to be set at a positive voltage equal to or greater than the negative voltage set by the CW-START FREQUENCY potentiometer to allow the marker input sweep to go through zero volts.

V13 is a differential amplifier with one grid input, pin 2, at ground reference and the other grid, pin 7, connected to the summing network of R115, R116 and R117. The push-pull output from the plates of V13 is connected to the grids of a second differential amplifier V12. The output of V12 is connected to the grids of cathode follower V14. V14 acts as a full wave grid controlled rectifier to produce at its cathode a rectified sawtooth with its lower limit or tip at about +150 volts. This tip corresponds to the region of the reference sawtooth that reduces the input at V13 (left side) to zero. Divider resistors R127 and R128 are selected so that at their junction, the lower limit of the rectified sawtooth is about -6 volts.

The diode CR16 transmits only the negative portion of the input at its cathode. When it is in the non-conducting state, the base of the marker is at ground level.

The overall gain of the circuit is such that the width of the marker is not more than .5 percent of the total sweep.

Drift due to parallel mode operation and tube changes is minimized through the use of negative feedback. This is obtained by connecting the cathode resistor of V13 to the junction of R128 and R129.

MARKERS potentiometer R213 is common to both marker circuits and permits the simultaneous setting of the amplitude of the two markers from zero to approximately 15% of the RF level. SWEEP selector switch SW2B-2 disconnects the markers from R123 when it is in EXT and OFF positions to prevent markers from affecting RF output.

2-15 POWER SUPPLIES

Refer to Figure 4-8 for this portion of the circuitry.

2-15-1 +3000 Volts

The secondary winding (5-6) of high voltage transformer T1 is connected to a voltage doubler circuit with rectifiers CR3 to CR8 charging C31 to 1500 volts during the positive half cycle and rectifiers CR9 to CR14 charging C32 to 1500 volts on the negative half cycle. The supply output is the sum of voltages across C31 and C32 which is total of 3000 volts. Resistors R147 through R150 serve as bleeders to drain off the high voltage charge on C31 and C32 when the circuit is turned off.

2-15-2 -300 Volts

The -300 volt supply is electronically regulated to maintain a constant voltage with minimum ripple and drift. Transformer T3 (winding 2-9) furnishes the plate voltage for full wave rectifier V33 with an output of 450 volts across filter capacitor C47A. R243 is a bleeder resistor to drain the charge off C47A when the circuit is de-activated. V34 serves as a series tube to drop the voltage to 300 by control of its grid. V38 is a differential amplifier with one grid connected to a precision resistor network sampling a proportional part of the output voltage, and the other grid connected to a fixed value relative to the plate as set by regulator tubes V36 and V37. Any change in the -300 volt output will cause a change in the grid inputs to produce a push-pull output from the differential amplifier. The amplified output of differential amplifier V38 is connected to the grids of V35 with the left half employed as an amplifier and the right half as a cathode follower. Connected in this manner the differential signal is effectively applied to the grid and cathode of the left half of V35 so it produces an amplified single ended output for controlling the grid of V34. Thus a very small variation in the -300 volt line would instantly appear highly amplified at the grid of V34 to produce the necessary correction to concel the variations. The high amplification also reduces ripple to a minimum. The screen grid supply for V34 is obtained from rectifier circuit CR20, C51, R242, C52 and 115 volt secondary of regulating transformer T4. Since the 115 volts from T4 is regulated, the +110 volts to the screen grid is essentially constant.

2-15-3 +300 Volts

The +300 volt circuit operation is similar to the -300 volt supply except that the

first differential amplifier V32 utilizes the precisely controlled -300 volt line as a stable reference instead of regulator tubes. This assures equal positive and negative plate voltages. Trimming potentiometer R197 corrects for tolerances in sampling resistors R196 and R198 to give precisely equal output voltages necessary for marker circuit accuracy. The grids of V32 are at zero volts when the output is exactly -300 volts and any variation from +300 volts produces an error which is amplified and passed on to the grids of V31 in a similar manner as in the -300 volt supply.

2-15-4 Solenoid Supply

Refer to Figure 4-9 for this portion of the circuit.

The solenoid power supply provides constant current to the solenoid independent of solenoid temperature or line voltage variations. Differential amplifier Q301 and Q302 develops an output current dependent upon the difference between the reference voltage obtained from the 6.8 volt zener diode ZD301 by R301, R303 and potentiometer R302, and the voltage developed by the solenoid current across R308. This output current is applied to the base of emitter follower Q303 and hence to the base of Q304, which, with emitter follower Q305 acts as a series regulator. The voltage drop across the regulator is divided, Q304 and Q305 each absorbing about one half of the total drop. There is sufficient gain in the amplifier to keep the difference voltage quite small at Q301 and Q302 bases, thus assuring regulation better than ± 1% with line or solenoid temperature changes.

2-16 POWER AND SWITCHING

All primary power to the instrument is made through chassis connector J301, interconnecting cable connector P1, POWER switch SW8 and the thermal switch located in the solenoid L302. All power is removed if the interconnecting cable is disconnected or the solenoid temperature exceeds 200° F.

Separate fuses are provided for the solenoid, power and RF sections of the instrument.

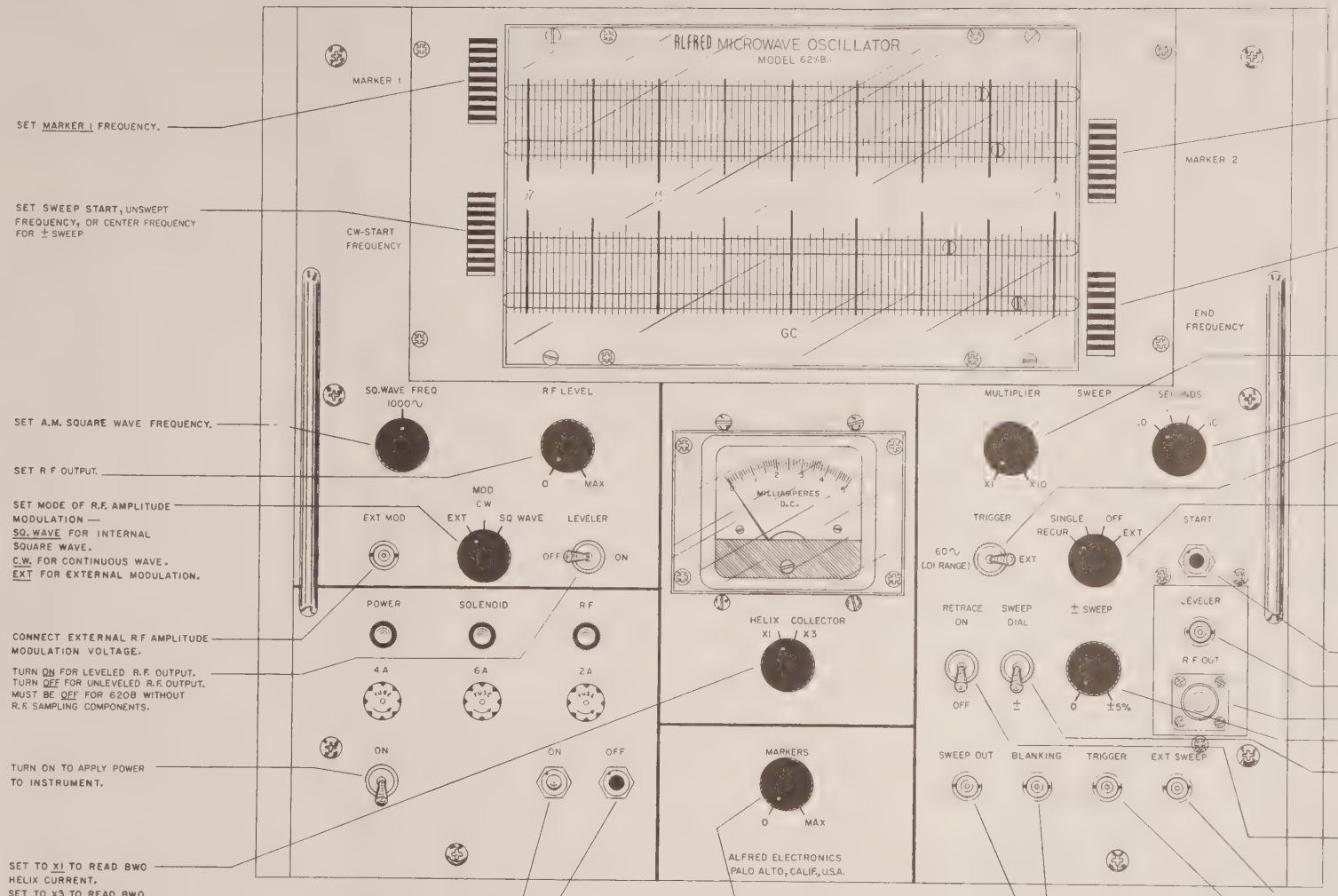
The regulated power supplies, filament supplies, blower and solenoid are energized with the closing of POWER switch SW8. The high voltage power supply requires the additional closing of momentary RF ON switch SW6. The closing of SW6 applies 115 volts to holding relay K1 through R151 and RF OFF switch SW7. The closing of relay K1 contacts energizes the primary of high voltage transformer T1 and the plate of V19B in the BWO anode supply. The coil of K1 is shunted by normally open K2. If the helix current becomes excessive K2 closes, shorting out current in K1.

If the overcurrent relay K2 or RF OFF switch SW7 drops out relay K1, RF

power, BWO tube anode, helix and collector voltages are removed until RF ON switch SW6 is again depressed.

Panel lights I-1, I-2, I-3 are lit when their respective circuits are energized. The regulating transformer T4 furnishes a regulated supply through transformer T5 for all tube heaters that require constant voltage.

SYM	DESCRIPTION	NO	DATE	BY



SET MARKER 1 FREQUENCY.

SET SWEEP START, UNSWEPT FREQUENCY, OR CENTER FREQUENCY FOR ± SWEEP

SET A.M. SQUARE WAVE FREQUENCY.

SET R F OUTPUT.

SET MODE OF R.F. AMPLITUDE MODULATION —
SQ. WAVE FOR INTERNAL SQUARE WAVE.
C.W. FOR CONTINUOUS WAVE.
EXT FOR EXTERNAL MODULATION.

CONNECT EXTERNAL R F AMPLITUDE MODULATION VOLTAGE.

TURN ON FOR LEVELED R.F. OUTPUT.
TURN OFF FOR UNLEVELED R.F. OUTPUT.
MUST BE OFF FOR 620B WITHOUT R.F. SAMPLING COMPONENTS.

TURN ON TO APPLY POWER TO INSTRUMENT.

SET TO X1 TO READ BWO HELIX CURRENT.
SET TO X3 TO READ BWO COLLECTOR CURRENT.

PRESS TO ENERGIZE HIGH VOLTAGE AND RF CIRCUITS. ALLOW A 3 MINUTE WARM UP.

PRESS TO DE-ENERGIZE RF CIRCUITS.

SET MARKERS AMPLITUDE

-75V BETWEEN SWEEPS FOR CONTROL OF EXTERNAL DISPLAY.

INTERNAL SWEEP SAWTOOTH OUTPUT. +45 VOLTS PEAK

CONNECT TO EXTERNAL SWEEP VOLTAGE. 200 VOLTS FOR FULL RANGE SWEEP.

CONNECT TO EXTERNAL SWEEP TRIGGER. +20 VOLTS

SET MARKER 2 FREQUENCY.

SET END FREQUENCY OF INTERNAL SWEEP.

SET VERNIER SWEEP PERIOD

SET SWEEP PERIOD - COARSE

SET TRIGGER MODE —
EXT FOR SWEEP TRIGGERING BY START SWITCH OR BY EXTERNAL VOLTAGE.
60∿ FOR INTERNAL 60CPS TRIGGER. .01 SECONDS RANGE ONLY

SET SWEEP MODE —
OFF FOR UNSWEPT OUTPUT.
RECUR FOR REPETITIVE SWEPT OPERATION BETWEEN FREQUENCIES DETERMINED BY C.W. START AND END FREQUENCY INDICATORS.
SINGLE FOR TRIGGERED INTERNAL SWEEP.
EXT FOR SWEEP DRIVEN BY AN EXTERNAL VOLTAGE.

PRESS TO INITIATE SINGLE SWEEP.

CONNECT OUTPUT FROM R.F. SAMPLER. (620B ONLY.)

CONNECT TO R F LOAD.

SET ± SWEEP AMPLITUDE WHEN USING ± SWEEP.

TURN TO DIAL FOR SWEEP BETWEEN DIAL START FREQUENCY AND END FREQUENCY.
TURN TO ± FOR ± SWEEP SYMMETRICAL ABOUT C.W. START FREQUENCY SETTING.

TURN ON TO OBTAIN R.F. DURING RETRACE.
TURN OFF TO BLANK R.F. DURING RETRACE

FIGURE 3-1

OPERATING CONTROLS

PANEL OPERATING CONTROL LAYOUT
MODEL 620B SERIES

TOL: FRAC. ±1/64 DEC. ±.008 ANGLE ±1/2° UNLESS INDICATED OTHERWISE

ALFRED ELECTRONICS

DRAWN	DATE	APPR'D	DWG NO
JDD	6-62		9900SED

3-1 TRANSIT DAMAGE

Immediately upon receipt, carefully unpack and inspect the instrument for damage received from transit. Should any damage be found, follow procedure on "Shipment Damage Claim" page at the end of this manual.

3-2 POWER INPUT

Primary power requirements are 105 to 125 volts, 60 cps, 850 voltamperes. If operation at other voltages or frequencies is contemplated, consult manufacturer.

The three-conductor power cable supplied with this instrument is terminated in a polarized three-prong male connector recommended by the National Electrical Manufacturers' Association. The third contact is an offset round pin added to a standard two blade AC connector, and grounds the instrument chassis when used with an appropriate receptacle. To use this connector with a standard two-contact receptacle, only an adapter should be used that terminates the third contact in a short lead, which , when connected to the outlet mounting box, will ground the instrument chassis.

3-3 MOUNTING

This instrument is designed for either bench or rack operation in normal ambient temperatures. When setting up on the bench, be sure air intake and exhaust on the sides of the unit are in the clear and air flow is unrestricted. For bench use and semi-portable applications, the Model 620B series Oscillator is normally supplied with sheet metal sides containing carrying handles.

If the instrument is to be rack mounted, the screws on each handle side should be taken out and the sides removed. Unit is now ready for inserting into rack. Supports should be provided in the rack to carry the weight of the instrument upon insertion or removal. Also, air flow in the rack to and from the instrument must be unrestricted to prevent overheating.

3-4 OPERATING CONTROLS

In the following discussions panel controls are indicated by capital letters and underlined. Chassis controls are indicated by capital letters not underlined.

Refer to Figure 3-1 for the location of the panel controls and connectors.

POWER This switch controls all primary power to the instrument. Adjacent panel lamp indicates when power is on.

RF ON This button when pressed connects primary power to the high voltage

transformers in the instrument and energizes a holding relay. Electrode voltages thereby are applied to the Backward Wave Oscillator tube. Adjacent panel lamp indicates when high voltage is on.

RF OFF This button de-energizes the holding relay to remove high voltage. In order to prolong BWO tube life, it is best to leave high voltage on whenever the power is on. For standby operation, turn the RF LEVEL to zero. For short periods when RF is not desired, use RF OFF button.

MARKER 1 This control provides linear frequency adjustment of an electronically generated short triangular marker pulse. The point of the marker pulse occurs when the RF frequency is the value indicated by the frequency dial. Accuracy is ± 1%. The marker pulse reduces RF output a small amount and may be used to calibrate an external presentation or display.

MARKER 2 This control provides linear frequency adjustment of a second electronically generated marker, identical to Marker 1.

CW-START FREQUENCY This is a 10 turn control which precisely sets DC voltage applied to the Backward Wave Oscillator tube helix and therefore the frequency of the output signal. During non-swept operation it manually controls the output frequency. During internal sweep it determines the lower or sweep starting frequency. During ± sweep, it sets the center frequency.

END FREQUENCY This 10 turn adjustment controls the maximum value of BWO helix voltage and consequently the maximum operating frequency during swept operation. When using internal sweep, the frequency scan starts at CW-START FREQUENCY value and proceeds linearly in time to the END FREQUENCY value.

MOD This switch selects the type of amplitude modulation desired. In the EXT position, connection is made to the adjacent EXT MOD connector. In the CW position, modulation of the RF signal is removed. In the SQ WAVE position, an internal square wave generator alternately turns RF off and on; the RF on level being the same as the unmodulated value.

SQ WAVE FREQ This control sets the frequencies of the internal square wave generator and covers the range of 800 to 1200 cps.

RF LEVEL This control sets the reference voltage into the leveler amplifier, which in turn determines cathode bias on the BWO tube, its beam current, and the RF output level. This control should be turned down on standby operation as discussed under RF OFF.

LEVELER This switch selects leveler amplifier feedback from either its own output or the RF sampling components. When in ON position and when RF sampling components are used, internal in 620BK or external with 620B, auto-

matic control of the BWO RF output results. This gives essentially constant RF power at any level set by RF LEVEL control, regardless of frequency or changes in the BWO characteristics. If the RF sampling components are not connected to Model 620B no harm can result but RF LEVEL adjustment will be extremely sensitive. When LEVELER switch is in OFF position, no leveling occurs and BWO tube is operated outside the feedback loop. RF power variation with frequency and RF LEVEL control setting, depends entirely upon BWO characteristics.

HELIX X1 - COLLECTOR X3 This switch connects the panel meter to monitor the BWO helix or collector current with appropriate shunts. In HELIX X1 position, meter indicates helix current on a 5 ma scale. In COLLECTOR X3 position, the meter scale reading should be multiplied by 3 and the collector current is thereby indicated on a 15 ma range.

MARKERS This control simultaneously varies the amount of RF reduction from 0 to about 15% by both frequency marker pulses.

RECUR-SINGLE-OFF-EXT This switch determines the voltage waveforms applied to the BWO tube helix and hence the type of frequency variation.

In RECUR position, an internal sawtooth voltage is selected to scan repetitively, the frequency of the RF signal, linearly from low to high over the range bounded by CW-START FREQUENCY and END FREQUENCY dial settings or symmetrically (up to ±5%) about the CW-START FREQUENCY setting depending upon setting of ± SWEEP control.

In SINGLE position, a single sweep voltage is applied to the BWO tube. This produces a linear increase of RF output frequency from low to high over the range bounded by CW-START FREQUENCY and END FREQUENCY dial settings. Upon arrival at the uppermost frequency, rapid retrace occurs. Output frequency remains at the starting value until the sweep is initiated again. Single sweep may be started manually by depressing the panel START button, electronically by an external signal, or repetitively on .01 sweep SECONDS range by an internal power line frequency (60 cps) trigger.

In OFF position a DC voltage determined by the CW-START FREQUENCY knob is fed to the BWO tube helix to produce a single, manually set frequency.

In EXT position, DC or AC signals applied to EXT SWEEP connector will be amplified and fed to the BWO tube helix. RF output frequency will vary in proportion to the external voltage.

SECONDS This switch determines the total period of the internal sweep generator, including flyback time.

MULTIPLIER This control provides X1 to X10 multiplication of the total sweep

period. Flyback time is constant, and in the X1 position is approximately 18% of total period. As the MULTIPLIER control is rotated, sweep time is increased making the flyback time proportionally less. In X10 position, flyback is about 1.8% of the total period.

START Pressing this button initiates a single frequency sweep, when the SWEEP switch is in the SINGLE position.

TRIGGER This switch selects the trigger for electronically starting the sweep. In the EXT position, a positive going signal 20 volts peak or greater, applied to the TRIGGER connector will initiate a single sweep. In the 60~ position, an internal waveform at power line frequency repetitively triggers the single sweep when sweep SECONDS switch is on .01 setting.

RETRACE With this switch OFF, RF power is zero during retrace. With it ON, RF remains on continuously.

SWEEP When SWEEP switch is turned to DIAL, sweep will be from CW-START FREQUENCY setting to END FREQUENCY setting. When turned to ±, sweep will be symmetrical about CW-START FREQUENCY setting.

± SWEEP Control adjusts the amplitude of the symmetrical sweep from 0 to ±5% of the total range.

3-5 PANEL CONNECTORS

EXT MOD With MOD switch in EXT position, signals applied to this terminal will modulate the RF. A negative signal will reduce RF. Fifteen volts maximum is required for 100% modulation. Output frequency will change slightly as the RF level is varied. This shift is usually less than 0.5% for a change from maximum to zero.

SWEEP OUT The internal sweep sawtooth voltage is inverted, attenuated and brought out to the SWEEP OUT connector. When SWEEP switch is in RECUR or SINGLE position, SWEEP OUT voltage is a positive signal proportional to frequency, rising linearly with time from zero to +45 volts during the sweep interval. Maximum load current is 1 ma. In the OFF or EXT position, no voltage appears at this connector.

BLANKING When the SWEEP switch is on RECUR or SINGLE position, voltage at this connector is zero during sweep interval. During retrace and non-swept periods it is approximately -75 volts. This signal may be used to blank an oscilloscope or lift the pen on a plotter during retrace and between single sweeps. Maximum load current is 4 ma.

TRIGGER When the SWEEP switch is in the SINGLE position and the TRIGGER switch in the EXT position, positive going signals 20 volts or greater applied to the

TRIGGER connector will start the frequency sweep. Any waveform may be used, including pulses as short as 1 microsecond. The input impedance is approximately 100 K shunted by approximately 100 μμf. Do not apply inputs in excess of 200 volts peak or damage may result.

The sweep, once started, will be unaffected by subsequent triggers. However, it may be restarted any time after flyback commences. Should a trigger occur in this interval a short premature sweep will occur. Flyback interval is 1.8% to 18% of total sweep period depending upon MULTIPLIER setting. Therefore, to prevent incorrect sweeps, the period of the triggering waveform should be longer than the flyback interval. In general, if sweep SECONDS and MULTIPLIER controls are set for sweep periods no greater than 4 times the trigger period, no erroneous sweeps will occur.

EXT SWEEP When the SWEEP switch is in the EXT position, signals applied to the EXT sweep connector will vary proportionally the frequency of the RF output from the value set by CW-START FREQUENCY indicator. Response to external sweep voltages is DC to approximately 10 kc. Negative going signals increase frequency. 200 volts peak to peak will scan the entire range. For example, with the CW-START FREQUENCY at the low end of the band, an external voltage varying from zero to -200 volts will scan the entire range. If the CW-START FREQUENCY is set at band center, a variation from +100 to -100 volts will sweep the entire band. Voltages up to 1000 volts accidentally applied to the EXT SWEEP connector will not cause harm. However, only voltages which produce frequencies within the operating range should normally be applied to this connector.

RF OUT The oscillator RF output is available from this connector.

LEVELER Model 620B only. When the leveler is to be used, depending upon the setting of the internal RF MAX control, -50 to -120 mv from a directional coupler and crystal detector at rated RF output should be applied to this connector. Output from ALFRED sampling components falls within this range. Note that sampling components with greater volts/RF milliwatt sensitivity will cause the leveled RF power to be lower since the leveler acts to maintain a constant voltage at its input. See Figure 3-2 for connection.

3-6 REAR CONNECTIONS

EXT FREQ See Figure 3-3. This connector permits external programming of the output frequency. To obtain remote operation, remove the cover plate and the jumper from terminals marked INT DC and EXT DC. A resistive divider or potentiometer of approximately 100 K total resistance should be connected between ground and -300 and the tap or slider connected to EXT DC. Wires may be fed through the hole in the cover plate. The plate should be reinstalled to protect terminals. The frequency output will vary linearly from minimum to maximum with the divider tap voltage. For example, if a frequency one third

EXTERNAL RF SAMPLER CONNECTIONS
(To obtain leveled operation of 620B)

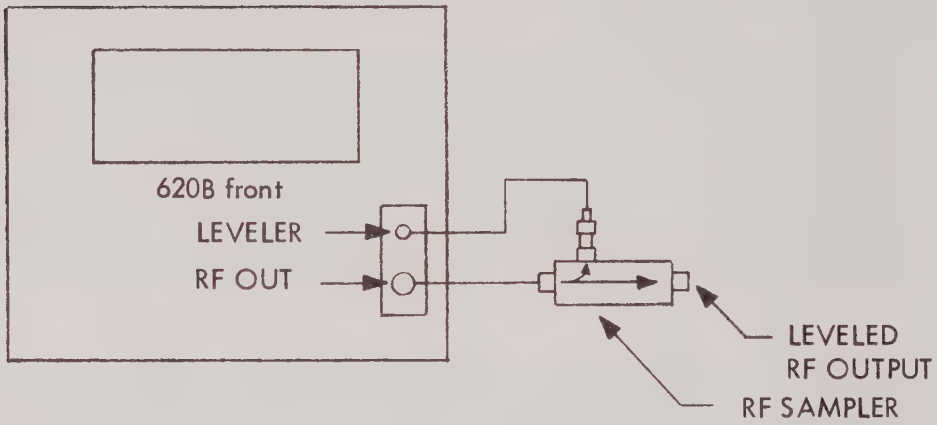


Figure 3-2

CONNECTION FOR EXTERNAL FREQUENCY PROGRAMMING

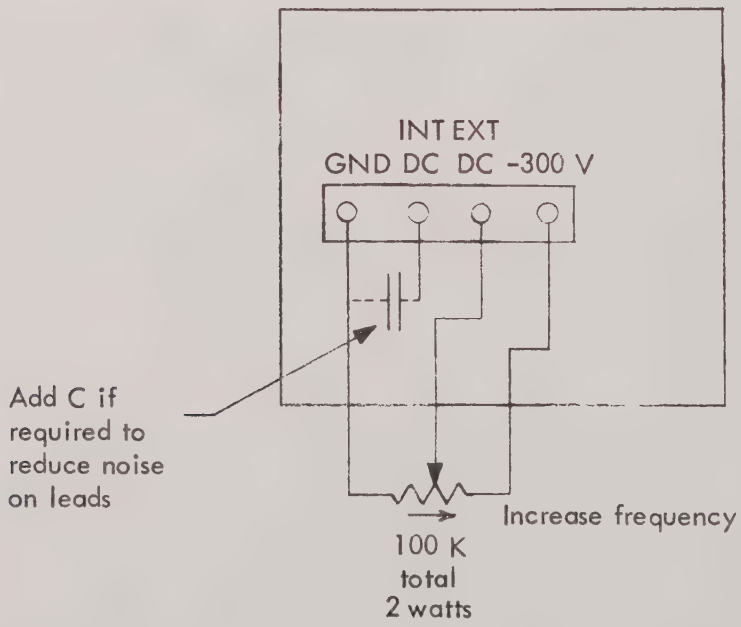


Figure 3-3

of the way across the dial is desired, a divider made up of 33.3 K and 66.7 K resistors would produce the desired frequency. CAUTION: One end of the divider will have -300 volts applied to it.

Alternatively, a stable DC source may be connected to EXT DC to provide frequency control. Note that any ripple or noise on the DC supply will cause frequency shift. The internal supplies are carefully regulated and filtered to minimize frequency variation.

SOLENOID I Solenoid current may be measured by connecting an ungrounded DC voltmeter across these tip jacks. Reading is 1 volt/amp of solenoid current. Typical value is 3.7 amperes. Actual current for this instrument is tabulated on the test data in the rear of this manual.

3-7 SETTING-UP PROCEDURE

Refer to the above description for procedures in using the operating controls and panel connectors.

1. With POWER switch off, set panel controls:

   RF LEVEL to 0
   MOD switch to CW
   SWEEP switch to OFF
   METER switch to HELIX X1
   MARKERS to 0

2. Make appropriate connections to EXT MOD, SWEEP OUT, BLANKING, TRIGGER and EXT SWEEP receptacles.

3. Connect load to RF OUT. Correct coaxial load impedance is 50 ohms. Mismatch loads do not affect oscillator performance, but will cause less power to be delivered. If external sampling for leveling 620B series units is required, connect RF sampling components between RF OUT connector and load. Also connect a video cable with BNC connectors from sampler crystal detector output to panel LEVELER connector.

   NOTE: For optimum performance of the instrument in measurement circuits, careful choice and use of detectors, RF cables, etc. must be made. Crystals can be used at any sweep speeds but many have frequency sensitive transfer characteristics. At medium sweep speeds bolometers give good performance in both frequency and sensitivity. Due to their long time constants, Barreters and Thermistors

may only be used on the slow sweep speeds. Avoid power losses by keeping RF cable lengths to a minimum and in good mechanical condition.

4. Turn POWER switch ON. Blower should start. Allow 3 minutes warmup, 15 minutes for leveler battery charge, if over 6 months since last use.

5. Set CW-START FREQUENCY control to desired frequency.

6. Press RF ON button. Note helix current should be negligible.

7. Set LEVELER switch to ON or OFF as desired. This switch must be in OFF position for Model 620B without external RF sampling components.

8. Slowly increase RF LEVEL control to MAX and note helix current should not exceed 3.0 ma. If helix current starts to exceed this value, set METER switch to COLLECTOR X3 position and note if collector current is in meter range. If too high, internal ANODE control requires resetting. If collector current is normal, BWO tube may require realignment in its solenoid to reduce helix current. Refer to the Maintenance Section of this manual for procedure in making these adjustments.

9. If external RF sampling components are used for leveling, refer to Maintenance Section 4 for setting of internal leveler adjustments.

10. If operation is normal, RF output will be rated value or greater and frequency within 1% of value indicated by CW-START FREQUENCY indicator.

11. Set MOD switch for amplitude modulation desired.

12. Set SWEEP selector switch for desired mode of sweep operation. If internal sweeps are to be used, set either END FREQUENCY or ± SWEEP control to proper band limit and sweep controls, SECONDS and MULTIPLIER for desired sweep interval.

    If single sweep mode is selected, the TRIGGER switch must be placed in EXT position except when 60 ~ triggering is desired. The EXT position is required for initiating the sweep by the START switch, or by external voltage applied to the

TRIGGER receptacle. The 60 ~ position of the TRIGGER switch should only be used when the SWEEP switch is on .01 seconds and MULTIPLIER control at X6.7 or less. 60 ~ triggering is removed on all other sweep second ranges.

13. Set MARKER 1 and MARKER 2 dial indicators to desired frequencies and MARKERS control for correct marker size.

14. Adjust RF LEVEL for desired power output. In LEVELER OFF condition, at the high end of the frequency range output varies faster with RF LEVEL control than at the low end. Thus during swept operation, as RF LEVEL is reduced, output will go to zero at the high end of the band before the low end. If low level output is required without adjustment over the full range, set RF LEVEL near or at MAX and externally attenuate RF output. In LEVELER ON condition RF LEVEL is held within rated flatness at any RF level.

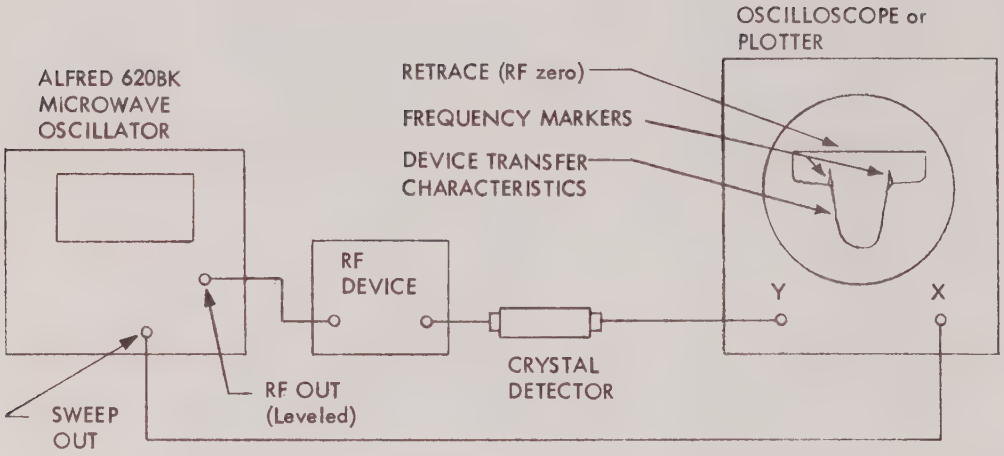
3-8 TYPICAL SET-UPS

Figure 3-4 shows a typical equipment set-up for displaying the transfer characteristic of a RF device. The transfer characteristic of the crystal detector should have variations within the measuring tolerance desired.

Figure 3-5 shows the equipment and connections of a typical set-up for measuring the reflected power and VSWR from a RF device. If the directional coupler is first reversed from position shown in Figure 3-5 and terminated, forward power may be then observed as a function of frequency. If the crystal detector has square law response, the plot at reduced values of forward power can be marked on the oscilloscope face by varying the Y-axis attenuator. These values may be chosen to simulate reflected to forward power ratios, which correspond to specific VSWR values:

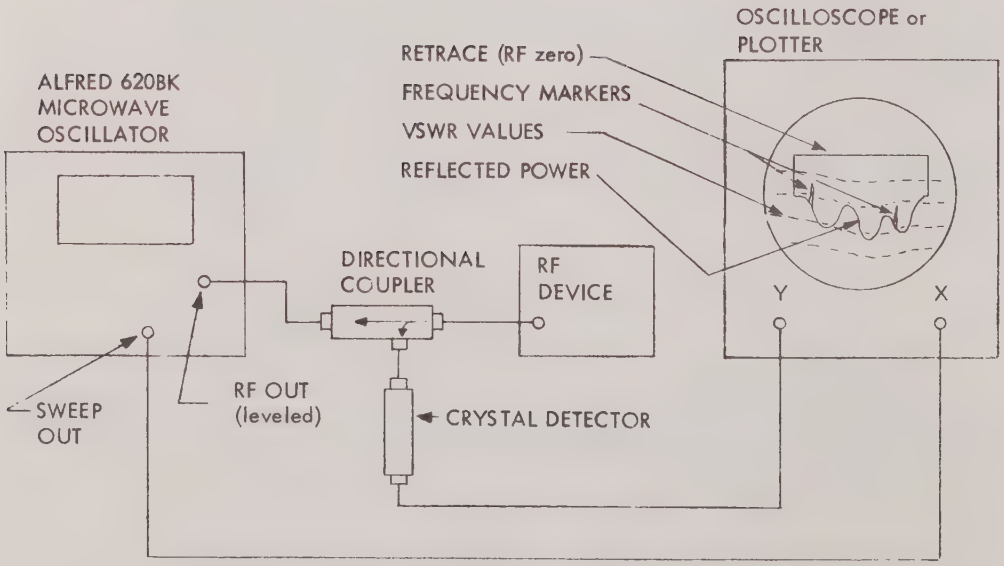
$$\frac{\text{Power reflected}}{\text{Power forward}} = \frac{(\text{VSWR} - 1)^2}{(\text{VSWR} + 1)^2}$$

Reversing the coupler to the position shown in Figure 3-5 will display reflected power but with Y-axis calibration directly in VSWR. At low VSWR values, accuracy will be primarily limited by directivity of the coupler.



MEASURING TRANSFER CHARACTERISTICS

Figure 3-4



MEASURING REFLECTED POWER AND VSWR

Figure 3-5

SECTION 4 - MAINTENANCE

4-1 GENERAL

CAUTION: Dangerous high voltages exist in this instrument. Observe the utmost care when checking or making repairs. Voltages as high as 3000 volts are present at certain points in the instrument.

Reasonable care should be exercised in handling and transporting the equipment to prevent damage. Repairs should be undertaken only by qualified personnel and with sufficient and accurate test equipment. Carefully analyze difficulties before dismantling instrument. Do not make unnecessary repairs or adjustments as this may impair the accuracy of the equipment.

Study the schematic diagram and instrument layout to become familiar with the location of danger points. Use extreme care not to touch these points or short circuit them by a probe. Accidental shorts may cause severe component damage before the fuses blow, and sometimes may cause high voltages to appear at otherwise low voltage points. Do not touch or try to remove any component in the high voltage sections when power is on. Note that all components on the bakelite boards are at helix potential and may be as high as 3000 volts. Be sure that whenever power is applied to the instrument, the instrument chassis is grounded. The instrument chassis is internally connected to the grounding wire in the power cord and the NEMA three prong connector. Do not jeopardize your safety by removing the round pin in the connector or using a three prong to two prong adapter that will leave the chassis ungrounded..

4-2 PREVENTIVE MAINTENANCE

Preventive maintenance need only consist of removing dust cover and performing the following:

1. Oil blower motor once every six months with a few drops of SAE #10-30 oil. Blower failure for any reason will cause over-heating and possible damage to the BWO tube. Oil holes are on top of motor, one at each end. To gain access to oil holes remove solenoid deck as described in chassis disassembly procedure, Paragraph 4-5.

2. At least once a year test all tubes on upper electrode supply chassis to detect marginal performance. Good tubes should be returned to their original sockets. Should a tube be replaced, associated controls should be recalibrated by procedures outlined later in this section. The following table lists the tubes which will affect calibration and the item affected. All other tubes may be replaced without adjustment.

Tubes

V2	SINGLE SW ZERO
V4, V5, V6	SWEEP AMP
V8	Check for sweep out to be less than 1 volt between single sweeps.
V9	Check leveler LIMIT
V10, V11	RECUR SW ZERO
V13	Check MARKER 1 accuracy
V17	Check MARKER 2 accuracy
V18, V19	START FREQ CAL, END FREQ CAL, and ANODE
V21, V22	Check helix voltage at minimum frequency setting for sporatic voltage spikes which may result from corona in an unsatisfactory tube.
V24, V25, V26	Check helix voltage for noise in excess of 35 mv.
V32	Set trimpot R197 underneath electrode supply accessible from rear of instrument, +300 volt value equal to -300 volt supply value.
V36, V37, V38	-300 volt supply output Select tubes for -300, ±3 volts.

3. As the BWO tube ages, preset ANODE potentiometer on upper chassis may require readjustment to maintain adequate RF output across the frequency range when RF LEVEL setting is at MAX. However, do not advance ANODE beyond point where collector current is greater than the maximum range of panel meter. If adequate RF output cannot be obtained, BWO tube should be replaced. When ANODE is changed, RF output frequency is also varied slightly. Calibration of CW-START FREQUENCY dial should be checked. Follow procedure in Paragraph 4-9 for internal adjustments.

4. Periodically inspect the instrument for accumulated dirt and moisture. Forced air under medium pressure is recommended for cleaning and drying. Screws and nuts should be checked occasionally for tightness. Care should be taken to avoid changing any internal adjustments during cleaning and inspection as this will necessitate recalibration of the instrument.

4-3 TROUBLE SHOOTING

Should trouble occur, follow a logical procedure to locate the cause. Refer to Theory of Operation section and the schematic and block diagrams included in this manual. Typical voltages and waveforms are indicated on these diagrams. The following are some servicing suggestions that may lead to the correct remedial action with a minimum of disassembly and service time. In general, a 20,000 ohm/volt meter is sufficient for measuring all voltages except at points of very

high input impedances such as grids or plates having high plate resistors. In these measurements a digital or VTVM, with at least a 10 megohm input impedance is recommended. For observing markers and waveforms, an oscilloscope with 10 meg input (X10 probe) is recommended.

1. Check fuses. Replace blown fuses with 250 volt, type 3AG.

2. Failure of the solenoid blower will cause overheating and may damage the BWO tube and solenoid. To minimize this danger, a normally closed thermal switch is installed in the solenoid to disconnect the primary power to the whole instrument if the solenoid temperature exceeds 200° F. Thus, if fuses are good but instrument cannot be turned on, check for either defective blower or thermal switch. Blower rotor may be observed through air intake holes on left side, to see if it is up to speed. Thermal switch may be checked with an ohmmeter on pins 5 and 6 of power socket J301 on solenoid deck. Remove bottom plate to get at this socket and be sure power cord is removed from the outlet.

3. If BWO helix current is high enough to trip out overcurrent relay, focusing magnetic field may be too low. Check solenoid current by connecting the positive lead of a high resistance DC voltmeter to the rear red test point TP301, and the negative lead to the black test point TP302. Meter should indicate typically 3.75 ± .2 volt. If the voltage reading is incorrect, the solenoid supply is faulty. If correct, V20 may be defective or the BWO tube may need alignment. This procedure is described later in this section.

4. Remove dust cover and observe tubes to determine if heaters are operating and voltage regulators are lit.

5. If improper operation is indicated and power can be applied to the instrument without blowing fuses, check outputs of all panel receptacles to see if faulty operation exists in more than one general area. If two or more areas are indicated, in all probability a power supply is at fault.

   The +300 volt supply can be checked at the common end junction of MARKER 1 and MARKER 2 potentiometers (red lead).

   The -300 volt supply can be checked at the CW-START FREQUENCY potentiometer (lug near dial box - purple lead).

   The 3000 volt supply can be checked at the plate connectors of tubes V21 and V22. CAUTION: Have RF POWER "OFF" when making or breaking connections in this area.

6. If any of the above checks lead to a faulty power supply (see Figure 4-8):

   a. Check tubes, either by replacement method or by tube checker, in the faulty section.

   b. See if one of the circuits using the supply is excessively loading it. This may be done by removing tubes and/or checking resistances at various points.

7. Low or no RF output:

   a. Check helix and collector currents.

   b. If the currents are normal, the BWO tube or its RF connections may be defective.

   c. If the currents are not normal, the BWO electrode control voltages are probably incorrect. Check solenoid supply, Figure 4-9. Check BWO electrode voltages as outlined in Section 4-4.

4-4 BWO ELECTRODE VOLTAGE MEASUREMENT

Remove screen dust cover. Disconnect BWO power plugs P8, P9 and set operating controls as follows:

1. CW-START FREQUENCY dial set at low end of band.
2. MOD switch to CW.
3. SWEEP switch to OFF.

BWO tube voltages may be measured in the following manner.

Heater: Connect AC voltmeter to pins B and C of J8. Voltage should be 6.3 to 7.0 volts.

Cathode: Connect DC voltmeter negative lead to chassis ground and positive lead to the one pin connector J9. With RF LEVEL at MAX voltage should be from 0 to +3.5 volts. With RF LEVEL at MIN voltage should be from 5 to 27 volts.

Anode: Connect DC voltmeter positive lead to pin A of J8 and the negative lead to chassis ground. Preset ANODE control will vary this voltage from about 25 to 250 volts. Reset after checking. Typical anode voltage falls between +75 and +150 volts

Helix: Connect DC voltmeter to positive lead pin D of J8 and the negative lead to chassis ground. CW-START FREQUENCY control will vary helix voltage over rated values for the BWO tube. These should be within the rated range of 150 to 2400 volts. Check voltage readings against values on BWO data sheet at rear of this manual.

Collector (above helix): Connect the positive lead of a high resistance DC voltmeter to pin E of J2 and the negative lead to pin D. Voltage should be 45 to 56 volts for any setting of CW-START FREQUENCY control. CAUTION: Use ungrounded voltmeter.

Grid: Connect DC voltmeter, the positive lead to pin F and the negative lead to ground. Reading should be +3.8 to +4.3 volts.

4-5 CHASSIS DISASSEMBLY PROCEDURE

Refer to Figure 4-1. To gain access to underchassis components, remove screen dust cover, set instrument upside down and remove bottom plate. Solenoid supply under chassis components are now accessible. For access to underside of electrode supply chassis or solenoid top chassis components, remove solenoid deck in the following manner:

1. Remove 6 screws at side edges of chassis that hold solenoid supply deck to the upper chassis.

2. Remove panel screw holding RF connector on 620B Series only. Disconnect BWO RF cable from sampler on 620BK Series only.

3. Unscrew the cable clamp on the air manifold of the solenoid deck and disconnect the plugs on BWO power cable and yellow-white cathode lead.

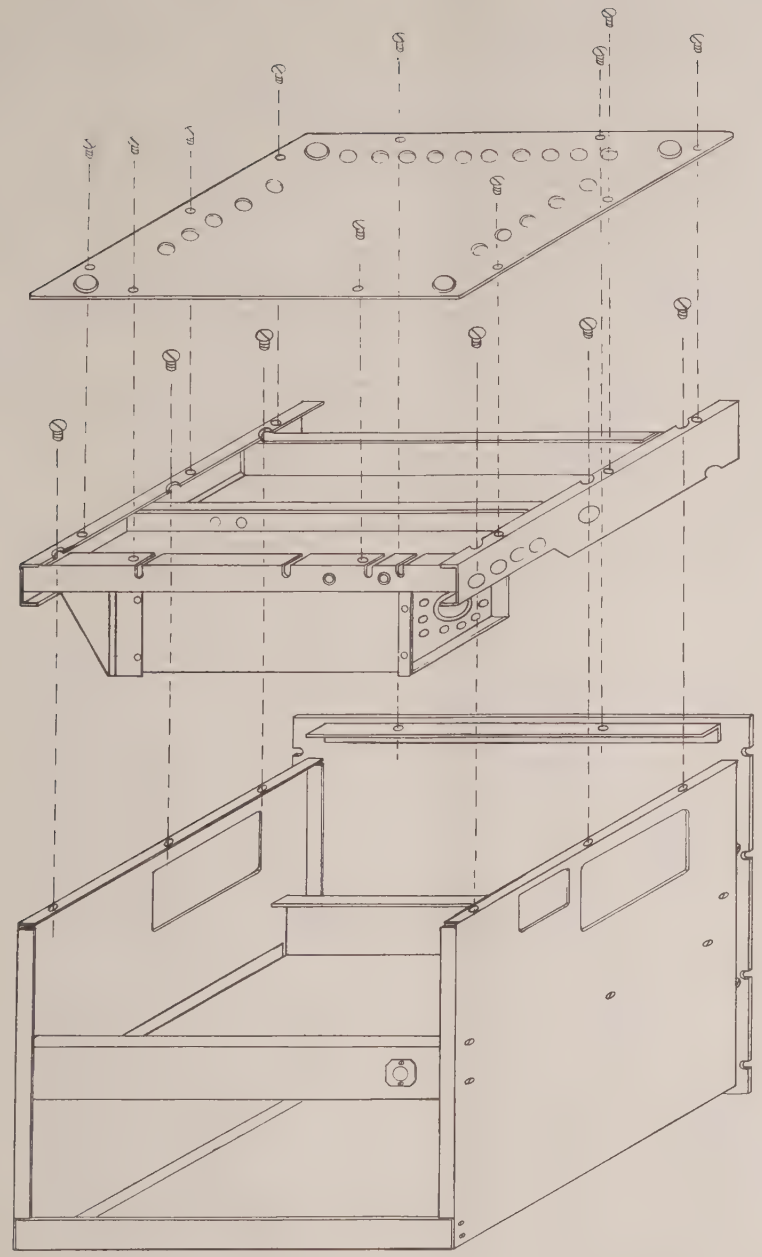
4. Slide solenoid chassis rearward about 4".

5. Disconnect octal power plug near panel power switches.

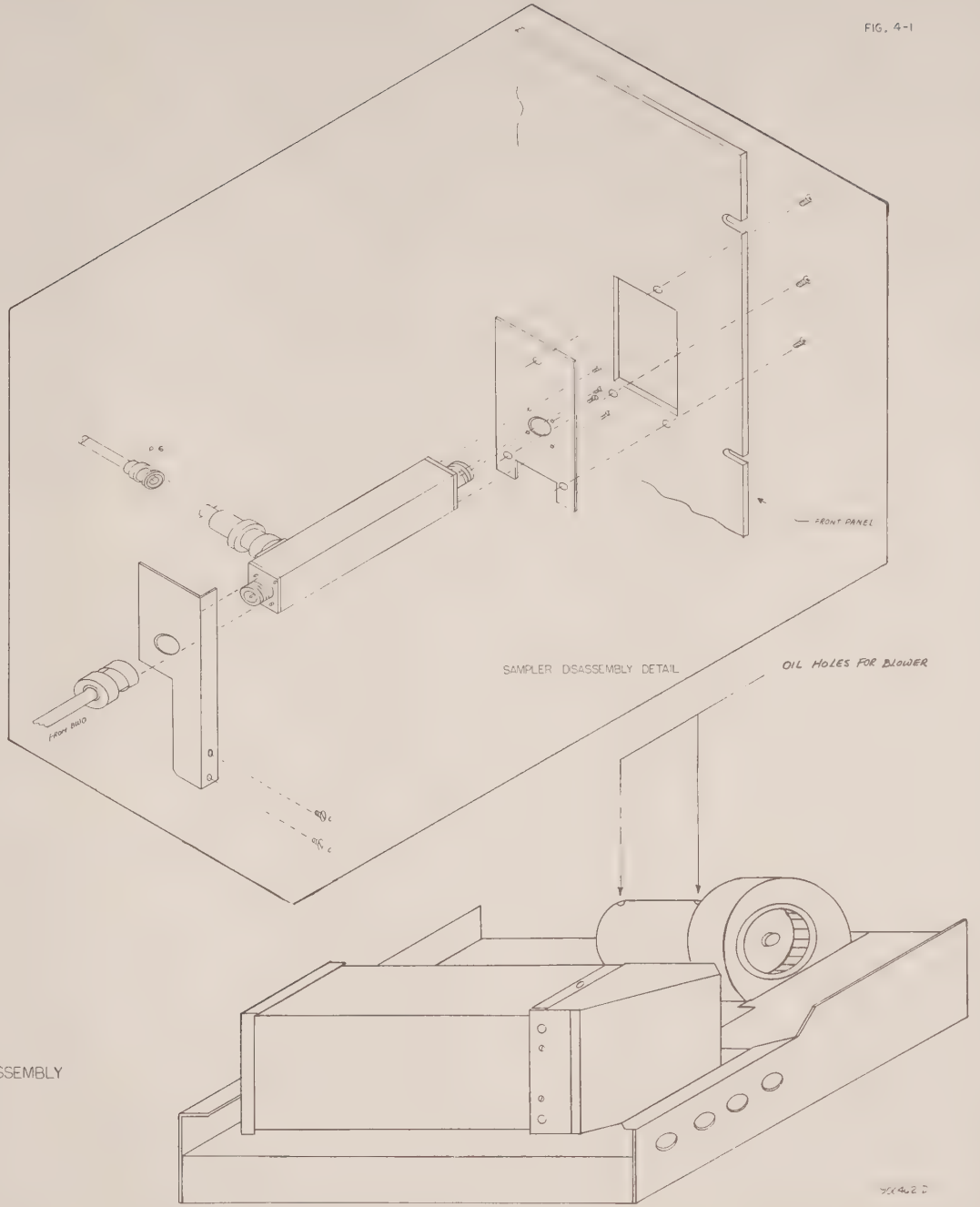
6. Chassis is now free. Use front and rear edge for lifting. CAUTION: SOLENOID DECK WEIGHS 45 LBS. USE SAFE, CAREFUL PROCEDURE WHEN HANDLING DECK WITH BWO TUBE INSTALLED.

4-6 RF SAMPLER REPLACEMENT

See inset on Figure 4-1 for sampler mounting. If sampler requires service, remove screws holding sampler as shown and return complete sampler to the factory. Do not attempt to remove the crystal detector from the directional coupler as the two are matched at the factory for correct performance.



CHASSIS DISASSEMBLY



SAMPLER DISASSEMBLY DETAIL

FIG. 4-1

4-7 BWO TUBE REPLACEMENT

To replace the Backward Wave Oscillator tube, remove both gray handle sides by taking out the 5 side screws. Remove top dust cover. Set instrument upside down and remove bottom plate.

On 620B remove the screws on the panel RF OUT connector. On 620BK remove BWO RF connector from sampler. Loosen the BWO locking bars at solenoid ends. From left side disconnect BWO power connectors and loosen clamp holding folded power cable. Loosen two screws holding air manifold cover plate and slide it forward to free it. Slide the tube out the right end of the solenoid through the side of instrument, pulling power cable through the solenoid.

Follow reverse procedure in installing new tube. Insert BWO until edge of cable slot at the RF output end of the capsule is in line with the edge of the solenoid ring. Observe due caution to prevent damaging tube. Be sure to fold excess power cable and place it in the clamp on air cover plate.

Align tube according to procedure below except the ANODE control may need to be reset to obtain proper collector current when RF LEVEL setting is at MAX. Rated helix and collector currents are noted on data sheet furnished with new tube.

Frequency dial will also have to be calibrated to new BWO tube. Follow INTERNAL ADJUSTMENTS procedure for setting START FREQ CAL and END FREQ CAL potentiometers. Also spot check CW-START FREQUENCY indication at other frequencies in the band. Start and end frequencies may require slight change to bring entire dial scale within ±1% accuracy. In addition, leveler LIMIT and STAB controls may require resetting.

4-8 BWO TUBE ALIGNMENT

Alignment of the BWO tube is accomplished in the following manner:

1. Set controls as follows;

   LEVELER switch to OFF
   RF LEVEL at MIN
   MOD switch to CW
   SWEEP switch to OFF
   CW-START FREQ about midband.

2. Alignment screws are at an angle through the holes in the solenoid deck at the edges of the solenoid end plates.

3. Turn on POWER switch. After about 3 minutes, press RF ON button.

4. Position BWO tube with the adjusting screws to obtain the lowest helix current, all the while increasing RF LEVEL towards MAX. ADJUST CAREFULLY. DO NOT DAMAGE TUBE CAPSULE BY CRUSHING IT AGAINST SOLENOID. On new BWO tubes do not exceed rated collector current stated on tube data sheet.

   Should helix current accidentally exceed 3.0 ma, overcurrent relay will shut off power supply. Operation can be restored by depressing RF ON button.

   Positioning of the BWO tube is most easily accomplished with two screwdrivers, one in each hand. Starting with the tube approximately in the center of the hole, slowly wobble the tube with the alignment screws, to minimize helix current. Adjust, alternately, both front screws then both rear screws, and perhaps one front and one rear. After a minimum setting is reached, one screw should be turned, usually causing helix current to increase, and then the null relocated by turning a different screw. Often the new null is lower than the original. Reverse direction of turning if the new null is higher. With a little care, helix current can usually be reduced to a safe value.

   Slight rotation or axial movement of the BWO tube may also result in a lower minimum. For best focusing, the RF output lead of the BWO should be very close to the solenoid end ring. Minimum helix current up to about 3.0 ma is quite safe. However, the lower the current the less chance that gas will be driven from the helix due to heating. Gas would soon damage the cathode emission and render the BWO tube inoperative.

Connect a RF power meter to RF OUT connector. Set RF LEVEL at MAX, MOD switch to CW, and meter switch to COLLECTOR X3. Move CW-START FREQUENCY control across entire band. Check RF power output to assure it is 10 milliwatts or greater. If necessary, reset ANODE potentiometer to obtain adequate output but do not increase collector current more than 2 ma beyond recommended value on BWO tube data page. If power cannot be measured, set ANODE for collector current about 0.5 ma above recommended value.

If difficulty is encountered either in reducing helix current or obtaining adequate RF output at low end of the band, reversing solenoid connections sometimes will improve performance. Disconnect AC power cable. Reverse leads at solenoid terminals on underside of solenoid deck. Reconnect power and continue alignment.

When satisfactory performance has been achieved, tighten locking screws enough

to prevent tube from being axially displaced or rotated in the solenoid, but not so tight as to dent the tube capsule.

4-9 INTERNAL ADJUSTMENTS

By proper design and use of precision components, internal adjustments have been kept to a minimum. Normally, the factory settings need be changed only when a tube or other component has been replaced. See Figure 4-2 for location of adjustments. Remove top dust cover for access.

START FREQ CAL This potentiometer determines BWO tube helix voltage at low end of the band. Set panel SWEEP switch to OFF and CW-START FREQUENCY to lowest frequency. With a wavemeter connected to RF OUT, adjust START FREQ CAL potentiometer to give correct frequency at lower edge of band.

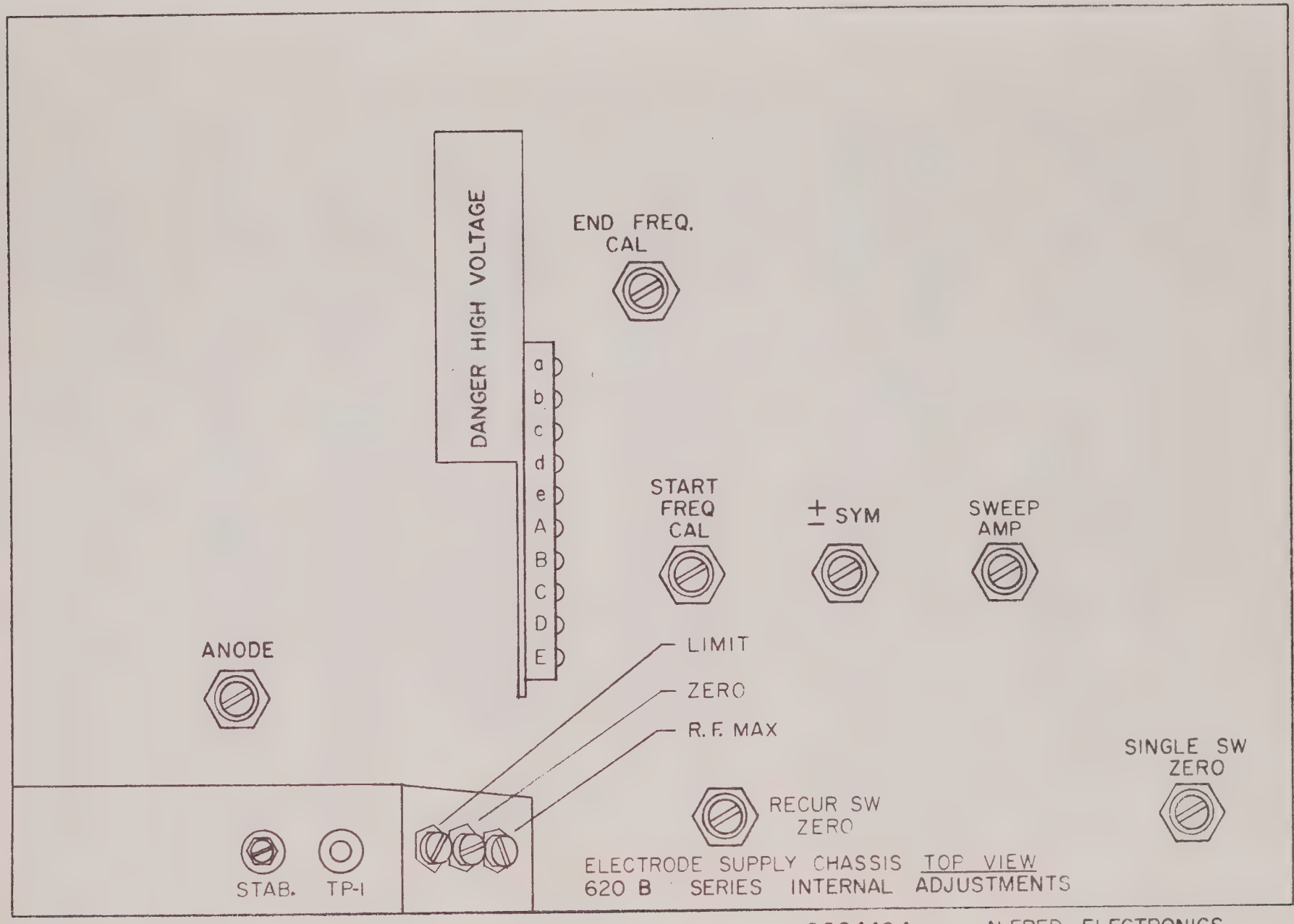
END FREQ CAL This potentiometer produces a fine adjustment of the maximum BWO tube helix voltage. With SWEEP switch at OFF and CW-START FREQUENCY control at its highest frequency, observe RF output on a wavemeter and set END FREQ CAL control for correct frequency. If voltage adjustment is beyond range of END FREQ CAL potentiometers, jumpers on the precision resistors may have to be changed.

Clockwise rotation of END FREQ CAL potentiometer decreases resistance to increase RF frequency. Thus, if frequency is too low add jumpers as necessary to short input resistors R75 through R79 until proper frequency can be obtained. If frequency is too high, remove jumpers. Note, that in order to retain correct frequencies during sweep, correspondingly lettered resistor in input string R83 through R87 must also be shorted. Example: If A (R75) is shorted, then a (R83) must also be shorted.

When first installing a new BWO tube, adjustment may be speeded by first using a DC voltmeter to indicate helix voltage. Remove nearby cover marked DANGER HIGH VOLTAGE over feedback resistors and connect a positive lead to lug with heavy black lead on the resistor board and the negative lead to chassis ground. Set START FREQ CAL and END FREQ CAL potentiometers for approximately the required voltages at each end of the band. These are indicated on the data sheet supplied with the BWO tube. Use a wavemeter for the final frequency calibration.

RECUR SW ZERO This control adjusts the DC level at which recurrent sweep starts. Set SWEEP switch in RECUR position. Observe the negative going sweep voltage on a DC oscilloscope connected to the gray lead on the dial END FREQUENCY potentiometer. Adjust so that start of sweep occurs at exactly zero voltage. If a suitable oscilloscope is not available, zero voltage can be calibrated using a DC voltmeter at very slow sweep rates.

SINGLE SW ZERO Repeat above with DC voltmeter and with the panel



ELECTRODE SUPPLY CHASSIS TOP VIEW
620 B SERIES INTERNAL ADJUSTMENTS

900446 A ALFRED ELECTRONICS
1-4-62

FIG. 4-2

SWEEP switch at SINGLE, adjust SINGLE SW ZERO for zero volts.

± SYM Connect a DC oscilloscope or DC voltmeter to point "a" on the top of the main chassis. Set the panel controls for ± SWEEP, full 5% amplitude and sweep SECONDS to .01 position. Set ±SYM so that no DC voltage is measured at "a".

SWEEP AMP Connect a DC calibrated oscilloscope or high accuracy meter to gray wire on the dial END FREQUENCY potentiometer. Adjust SWEEP AMP control for 200 ±2 volts peak sawtooth sweep voltage. Sweep time must be set for a long interval if a meter is used so its needle will follow accurately.

ANODE This potentiometer sets the anode voltage to the BWO tube to obtain the correct operating currents for rated RF power output. When first installing a new BWO tube, first set ANODE control fully counterclockwise. Rotate clockwise to increase BWO tube currents to values indicated on tube data sheet. Slight readjustment from this value may be necessary to obtain rated RF output throughout frequency range.

SOLENOID I Adjustment for solenoid current is accessible through a hole in the right hand side of the bottom deck. Current may be measured with an ungrounded DC voltmeter at terminals TP301 and TP302. The current in amps will be equal to the voltage measured. Nominal current is 3.75 amperes.

4-10 LEVELER INTERNAL ADJUSTMENTS

There are four internal leveler adjustments on 620BK series instruments. These adjustments should be checked when setting-up a 620B unit to make use of external RF sampling components, after repairs have been made to the leveler, or when a BWO tube has been replaced. They are located on the leveler box just below the top of the instrument.

ZERO This control is set at the factory. Resetting is not required unless a component in the leveler is replaced. If it is necessary to adjust this control it should be done as follows: Set the LEVELER switch to OFF, MOD to CW, and the RF LEVEL control so that the dot on the knob is at 3 o'clock. Connect a DC voltmeter to TP1 and set ZERO adjustment so that the meter reads +1 volt.

LIMIT If RF output does not go to zero when RF LEVEL is turned to 0, this control probably requires adjustment. Set controls so that instrument sweeps entire range, set LEVELER to OFF, and RF LEVEL to 0. To adjust LIMIT, turn limit adjustment counterclockwise until RF just goes to zero.

RF MAX Adjust this control to obtain rated leveled RF power when RF LEVEL is set to MAX, and LEVELER is ON. Obviously, on 620B series instruments without RF sampling components this control has no effect.

STAB Set this trimmer to obtain fastest rise without oscillation on leveled operation. To adjust, connect a crystal detector to the RF output and monitor the crystal with an oscilloscope of at least 10 mc/s bandwidth. Be sure to load crystal with a few hundred ohms so that its response will be very fast to both increasing and decreasing RF signals. Set SWEEP to 10 SEC, and set CW-START and END FREQUENCY for maximum range. Set MOD to SQ WAVE and RF LEVEL about mid-range. Set oscilloscope sweep to 1 μsec/cm and observe waveform. Rise time will be seen to decrease as frequency sweeps upward. Adjust STAB for minimum rise time, being careful not to allow oscillations to occur at any part of the sweep.

4-11 DIAL ASSEMBLY REPAIR

The dial assembly requires no lubrication and ordinarily no maintenance. However, in the event of a potentiometer failure, follow the procedure outlined below to effect repairs. Refer to Assembly Diagram, Figure 4-10 for location and identification of parts.

4-11-1 General

1. Remove screws holding dust cover and slide it back about 6 inches. Remove the screw and washer holding cable clamp (A).

2. Remove four 6-32 screws holding dial box panel (B) to instrument panel and the outboard screw on each side bracket (L) and (M). Lift the dial assembly up and lay it on top of the screen.

3. Unsolder leads to defective potentiometer and position its pointer at the left end of the dial.

4. Remove plastic dial plate (C) and the fiber spacing washers. Remove four 6-32 flathead screws from dial box panel (B) freeing it from dial box (D). When reassembling make sure the arrows on the back of dial box panel (B) point toward the top.

4-11-2 Replacing MARKER 1 Potentiometer (E)

1. Set pointer (9) about 1" from left end of dial and do steps outlined in 4-11-1.

2. Loosen set screw (3) and slide spiral rod (4) off the potentiometer shaft. Remove nut and washer (1) using a 3/8" end wrench freeing potentiometer (E).

3. Insert new potentiometer, secure it with washer and nut (1) then turn its shaft fully counterclockwise.

4. Set pointer assembly (5) 1/32" away from the shoulder on spiral rod (4). Slide the rod onto all but 1/32" of the potentiometer shaft. Rotate the rod counterclockwise until the pointer faces directly up, then tighten one set screw (3) through opening in rear of dial box (D).

5. Remount dial box panel (B) and run all other pointers to the left end of the dial box. Loosen set screw (3) and turn knob (2) clockwise until the pointer (5) is lined up with the other pointers. Tighten both set screws (3).

6. Reverse steps outlined in 4-11-1 to reassemble.

4-11-3 Replacing MARKER 2 Potentiometer (F)

1. Set pointer (5) about 1" from left end of dial and do steps outlined in 4-11-1.

2. Loosen two set screws (7) and slide spiral rod (8) to the right. Remove nut and washer (6) with a 3/8" end wrench freeing potentiometer (F).

3. Rotate shaft on new potentiometer fully counterclockwise, insert through the end plate (J) through washer and nut (6), and into the end of rod (8). Secure the potentiometer with washer and nut (6).

4. Set pointer assembly (9) 1/32" away from shoulder on spiral rod (8). Slide the rod onto all but 1/32" of the potentiometer shaft. Rotate the rod counterclockwise until the pointer faces directly up, then tighten one set screw (7) through opening in rear of dial box (D).

5. Remount dial box panel (B) and run all other pointers to the left end of the dial box. Loosen set screw (7) and turn knob (10) clockwise until the pointer (9) is lined up with the other pointers. Tighten both set screws (7).

6. Reverse steps outlined in 4-11-1 to reassemble.

4-11-4 Replacing CW-START FREQUENCY Potentiometer (G)

1. Set pointers (9) and (25) about 1 inch from left end of dial slots. Perform steps outlined in 4-11-1.

2. Loosen set screws (15) (between gear (13) and knob (14)) and slide rod (16) off the shaft of potentiometer (G) .

3. Using an offset 3/8" box or end wrench, remove nut (12) freeing potentiometer (G) (or remove rod assembly (16) and remove nut with a 3/8" spin-tite).

4. Insert new potentiometer with the spacing washer (11) into end plate (J) . Secure the potentiometer with nut (12) then turn its shaft fully counterclockwise.

5. Set pointer assembly (17) 1/32" away from shoulder on spiral rod (16) . Slide the rod onto the potentiometer shaft leaving 1/32" spacing between nut (12) and rod (16) .

6. Loosen set screws on gear (13) and rotate rod (16) counter-clockwise until pointer faces directly up. Tighten one set screw (15) through opening in rear of dial box (D) .

7. Set pointer assembly (25) 1/32" away from shoulder on spiral rod (24). Rotate the rod clockwise until the potentiometer (H) starts to rotate and the pointer (25) faces directly up.

8. Remount dial box panel (B) , and run all other pointers to the left end of the dial box. Loosen set screw (7) and turn knob (10) clockwise until the pointer (9) is lined up with the other pointers. Tighten both set screws (7) .

9. Turn knob (26) clockwise until edge of pointer is 1/16" away from end of dial. Tighten both set screws on gear (13) . (Tighten one screw first without moving any knobs. Dial box panel (B) might have to be removed to do this.)

10. Reverse steps outlined in 4-11-1 to reassemble.

4-11-5 Replacing END FREQUENCY Potentiometer (H)

1. Perform steps outlined in 4-11-1.

2. Loosen set screws (23) and on gear (22) freeing potentiometer (H). Remove potentiometer and unscrew threaded steel bushing (19) with padded gas pliers.

3. Unsolder contact rings (18) and replace on new potentiometer per Figure 4-10 (Detail #2) unless ordered specifically as potentiometer (H) from factory. Screw bushing (19) on

tightly with padded gas pliers and rotate the shaft fully clockwise.

4. Insert the potentiometer assembly through oilite bearing (20), through gear (22) and into the end of rod 24, making sure contacts (21) mate with contact rings (18). Tighten both set screws on gear (22) allowing minimum play (approximately .005") on other side of oilite bearing (20). Rotate gear (22) clockwise until it stops.

5. Set pointer assembly (25) 1/32" away from shoulder on spiral rod (24). Space 1/32" between end of rod and bushing (20). Rotate the rod clockwise until the pointer (25) faces directly up, then tighten one set screw (23) through opening in rear of dial box (D).

6. Remount dial box panel (B), and run all other pointers to the left end of the dial box. Loosen set screw (7) and turn knob (10) clockwise until the pointer (9) is lined up with the other pointers. Tighten both set screws (7).

7. Reverse steps outlined in 4-11-1 to reassemble.

4-11-6 Sources of Binding and Excessive Drag

1. Pointer rubbing on plastic dial plate (C) (Tap pointer down to approximately 1/32" above dial box panel (B)).

2. Knobs not centered, rubbing on edge of slot.

3. Nylon keeper screw in pointer assembly too deep.

4. Potentiometer shaft bent.

5. Rod (4) or (8) rubbing against potentiometer (E) or (F) shaft bushing (set for 1/32" spacing).

6. Rod (16) rubbing against nut (12). (Set for 1/32" spacing)

7. Rod (24) rubbing against steel bushing (19).

8. Not enough clearance on either side of oilite bearing (21). (Move gear (22) to the right just enough to free it.)

4-12 CALIBRATION OF MARKERS

To check the marker calibration follow the procedure outlined below.

1. Calibrate CW-START FREQUENCY at left end center and right end of dial using a calibrated wavemeter connected to RF OUT.

2. Turn MARKERS control enough clockwise for easy visual observation using crystal detector at RF output and an oscilloscope.

3. Dial presentation of markers should be within 1% of frequency calibration at any point. If deviation occurs, try new tubes in V13 and V17 sockets. If necessary check other electrical components by resistance measurements. Normally, tube replacement will bring calibration within limits unless a mechanical repair or disassembly to the dial assembly has occurred.

4. If the markers are out of calibration due to mechanical failure or dial disassembly, proceed as follows after the repair has been made. Refer to Figure 4-10.

MARKER 1

a. Set oscillator to sweep entire frequency band. Align marker 1 pulse with wavemeter pulse.

b. Loosen set screws (3) and rotate knob (2) until dial pointer (5) aligns with corresponding frequency line on dial plate (C). Tighten set screws (3).

c. Check several frequencies across the band. Readjust as in step b above, for ±1% accuracy anywhere on dial.

MARKER 2

a. Align marker 2 pulse with wavemeter pulse.

b. Loosen set screws (7) and rotate knob (10) until pointer (9) aligns with corresponding frequency line on dial plate (C). Tighten set screws (7).

c. Again check other frequencies and readjust if necessary for ±1% accuracy.

4-13 LEVELER SERVICING

Should the leveler require servicing, remove instrument dust cover. Take out screw on top of leveler and lift cover vertically. This will expose all leveler components and permit voltage measurements. Components are marked for easy correlation with the circuit diagram. Voltages may be measured at the leads of the components. Should a component require replacement, remove the screw on the flange beneath the leveler and unplug the unit. Components may be replaced from the top by heating the leads with a small soldering iron and removing the component with needle-nosed pliers. Use care not to overheat board or components.

4-14 BLOWER REPLACEMENT

Turn instrument upside down and remove bottom plate. Unsolder two blower motor connecting wires. Follow CHASSIS DISASSEMBLY PROCEDURE to free solenoid chassis. Remove chassis and place on a bench, top side up. Take out three screws holding blower to chassis. Take care not to disturb the BWO tube. Lift out blower assembly.

To replace blower motor take off ring on the side. Loosen wheel set screw with an allen wrench and pull the wheel off the end of the motor shaft. The two stop nuts holding motor are now exposed on inside of housing. Their removal will free motor. Reassemble using reverse procedure. Be sure motor is mounted with oil holes up. If entire assembly or housing alone is replaced, transfer aluminum brackets to new unit.

4-15 COAXIAL RF CONNECTOR

The BWO coaxial type RF OUT connector used on several models contains a special series capacitor and a small fine wire DC return. A teflon sleeve between the cable center conductor and the connector pin serves as the capacitor dielectric and silicon oil is added to improve dielectric strength. The cable center conductor is at the BWO helix potential of 150 to 2400 volts DC. The series capacitor isolates the high potential from the panel connector center pin. The small diameter wire connects the center pin to ground through a low DC resistance, but high RF impedance.

Should arc-over occur in the connector, the helix overcurrent relay in the instrument will trip out. However, should the fine wire burn open, high voltage may appear at the center pin upon reapplication of power. Therefore, take care to avoid shock or damage to external equipment connected to RF OUT when checking for failure. Use a voltmeter to determine if center pin is at high voltage.

If the connector failure is suspected but cannot be verified from the panel, take off the right gray handle side and disconnect RF cable from the BWO tube by unscrew-

ing brass cap. Use an ohmmeter between connector center pin and coax center conductor to determine if capacitor is shorted. If it has failed, remove panel screws holding connector and take out complete cable assembly. Remove rear ring on connector and disassemble it. If no simple repair is possible, the entire assembly should be replaced. Install new part carefully and reassemble instrument.

4-16 WARRANTY

All workmanship and materials except Backward Wave Oscillator tubes are guaranteed for one year. Details concerning warranty adjustments are presented on "Shipment Damage Claim" page at the end of this manual.

The Backward Wave Oscillator tube supplied in the unit is guaranteed for 500 hours of use or one year whichever expires first. Cost of an in-warranty replacement BWO tube will be prorated according to tube life obtained or time from delivery, whichever is greater. To obtain warranty service, requests should include a description of the failure, factors leading to it, and an accurate estimate of operating hours. Use the tube service report supplied at the end of this manual. Be sure to answer all questions fully.

4-17 DC VOLTAGE CHECKS

The following pages list nominal DC voltages measured with a digital voltmeter (10 megohm input) at tube and transistor pins. A 20,000 volt meter may be used but a slight allowance for its internal resistance must be made in the very high resistance circuits. A socket extender makes the voltages available at top of tube sockets so disassembly of the instrument chassis is not required. Remove leveler cover to make transistor voltage measurements. Solenoid supply transistors are accessible by removing bottom plate.

Tube No.	Remarks	Pin Number								
		1	2	3	4	5	6	7	8	9
V1	TRIGGER-EXT									
	SWEEP-OFF	274	0	16	0	0	55	16	16	0
V2	SWEEP-OFF	300	2	7	0	0	260	0	7	0
V2	SWEEP-RECUR	Pin 6	40 to 260							
V3	MULTIPLIER X1									
	SWEEP-OFF	3	3	40	0	0	300	260	260	0
V4	SWEEP-OFF					260				
V5	SWEEP-OFF					173				
V6	SWEEP-OFF		0		86					
V7	SWEEP-SINGLE	0	0	0	0	0	10.5	260	-10	0
V8	SWEEP-EXT	0	-86	-85	0	0	0	-85	-85	0
V9	SWEEP-EXT									
	MOD-CW									
	RF LEVEL-MIN	100	29	29	0	0	100	55	55	0
	RF LEVEL-MAX	92	.3	1.5	0	0	92	51	51	0
V10	SWEEP-OFF			0	0	0	95	-.2	0	0
V10	SWEEP-SINGLE	90	.2	0	0	0	275	-11	0	0
V11	SWEEP-OFF	300	-62	3.7	0	0	-3	-283	-276	0
V11	SWEEP-RECUR		28 to -63	+38 to -59			0 to -200			
V12	Marker 1 circuit, MARKER 1 pointer at mid-scale, CW-START at low end. END FREQUENCY at high end									
	SWEEP-OFF	84	40	40	0	0	240	17	40	0
	SWEEP-RECUR	251 to 93	31 to 40	37 to 40	0	0	88 to 240	37 to 17	37 to 40	0
V13	Same dial settings as for V12									
	SWEEP-OFF	40	0	1.7	0	0	17	2.4	1.7	0
	SWEEP-RECUR	30 to 40	0	.8 to 1.7	0	0	19 to 36	-.4 to 2.4	.8 to 1.7	0
V14	Same dial settings as for V12									
	SWEEP-OFF	300	84	252	0	0	300	240	252	0
	SWEEP-RECUR	300	88 to 235	247 to 251	0	0	300	88 to 240	247 to 251	0
V15*										
V16*										
V17*										

All voltages relative to chassis ground.

*MARKER 2 circuit approximately the same as MARKER 1 circuit values.

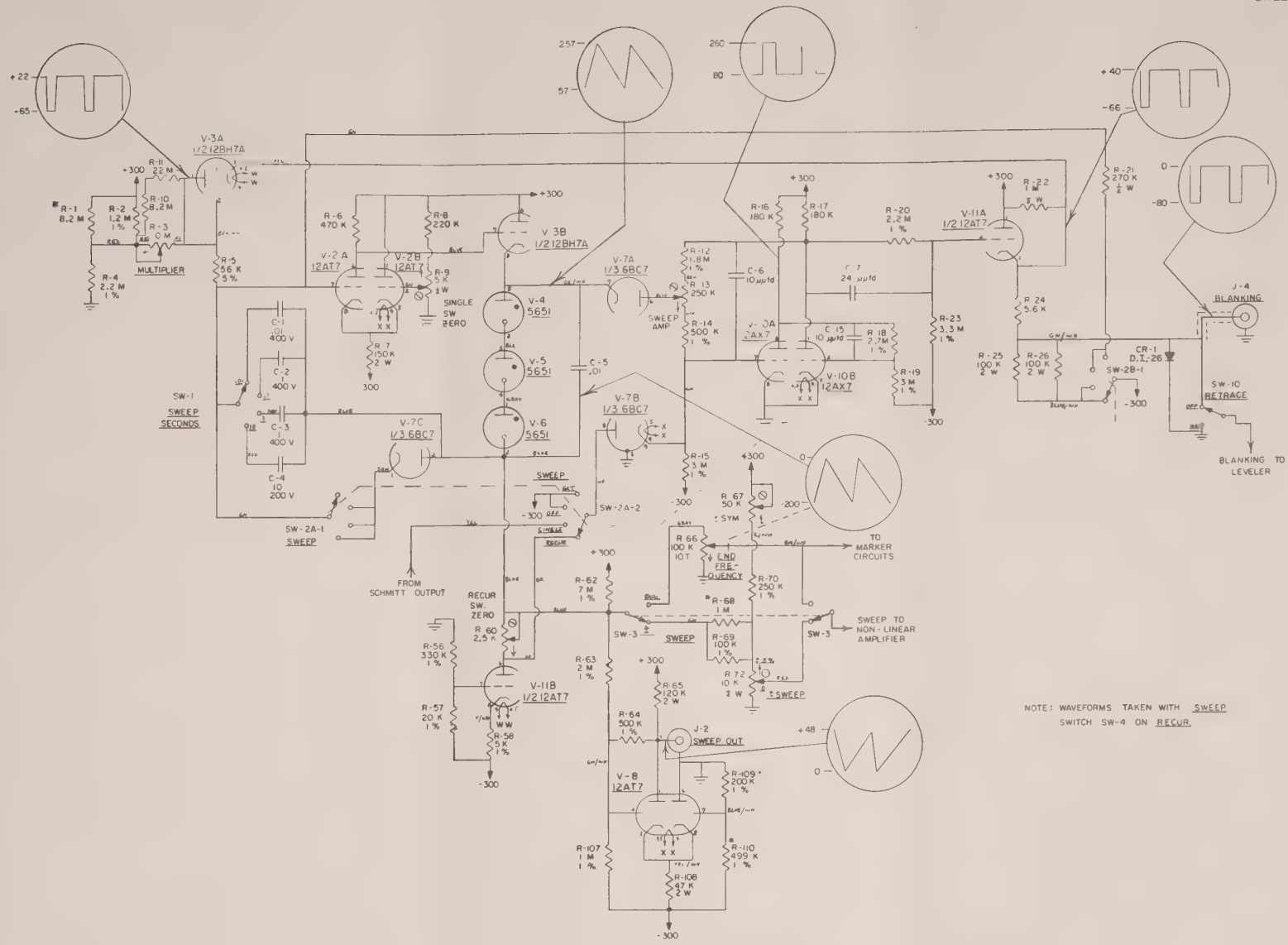
Tube No.	Remarks	Pin Number								
		1	2	3	4	5	6	7	8	9
V18	RF control circuit,									
	CW-START at low end, SWEEP-OFF, RF-ON	300	64	89	0	0	64	31	-.1	1.0
	CW-START at high end	300	73	96	0	0	73	32	-.2	1.0
V19	Same settings as for V18									
	CW-START low	300	**	**	0	0	70	31	0	1.0
	CW-START high	300	**	**	0	0	61	32	0	1.0
V20	Same settings as for V18									
	CW-START - low				105	70			89	
	CW-START - high				107	61			96	
	Plate cap **									
V21, V22 **										
V24		150	150***	0			125***	125	100***	100
V25		225	225***	0			200***	200	175***	175
V26		300	300***	0			275***	275	250***	250
V29	+300 volt supply							472		
V30	+300 volt supply	280	300	300		460		300	460	
V31	+300 volt supply	300	100	123	0	0	280	100	123	0
V32	+300 volt supply	100	0	1.1	0	0	100	0	1.1	0
V33	-300 volt supply							130		
V34	-300 volt supply	-65	0	0		119	91	0	91	
V35	-300 volt supply	0	-74	-89	0	0	-6.5	-14	-89	0
V36	-300 volt supply	0	-87							
V37	-300 volt supply					-87		-174		
V38	-300 volt supply	-74	-174	-173	0	0	-74	-174	-173	0

Transistor No.		Emitter	Base	Collector	
Q1	MOD SW to CW	+1.2	+.9	+1.1	
Q2	MOD SW to CW	+.9	+.65	+.7	
Q3	MOD SW to CW	+1.33	+1.1	+1.2	Some voltages will vary with RF LEVEL setting.
Q4	MOD SW to CW	+.25	0	-.25	
Q5	MOD SW to CW	+.25	0	-.25	
Q6	MOD SW to CW	0	-.25	-1.33	
Q7	MOD SW to CW	0	-.25	1.6	
Q8	MOD SW to CW	-1.33	1.6	-1.2 to +30 depending on RF LEVEL setting.	
Q301	Solenoid supply	-3.45	-3.7	-7.3	
Q302	Solenoid supply	-3.45	-3.75	-4.3	
Q303	Solenoid supply	-4.1	-4.3	-16.9	
Q304	Solenoid supply	-3.75	-4.1	-16.9	
Q305	Solenoid supply	-16.9	-17.1	-31.8	

All voltages relative to chassis ground.

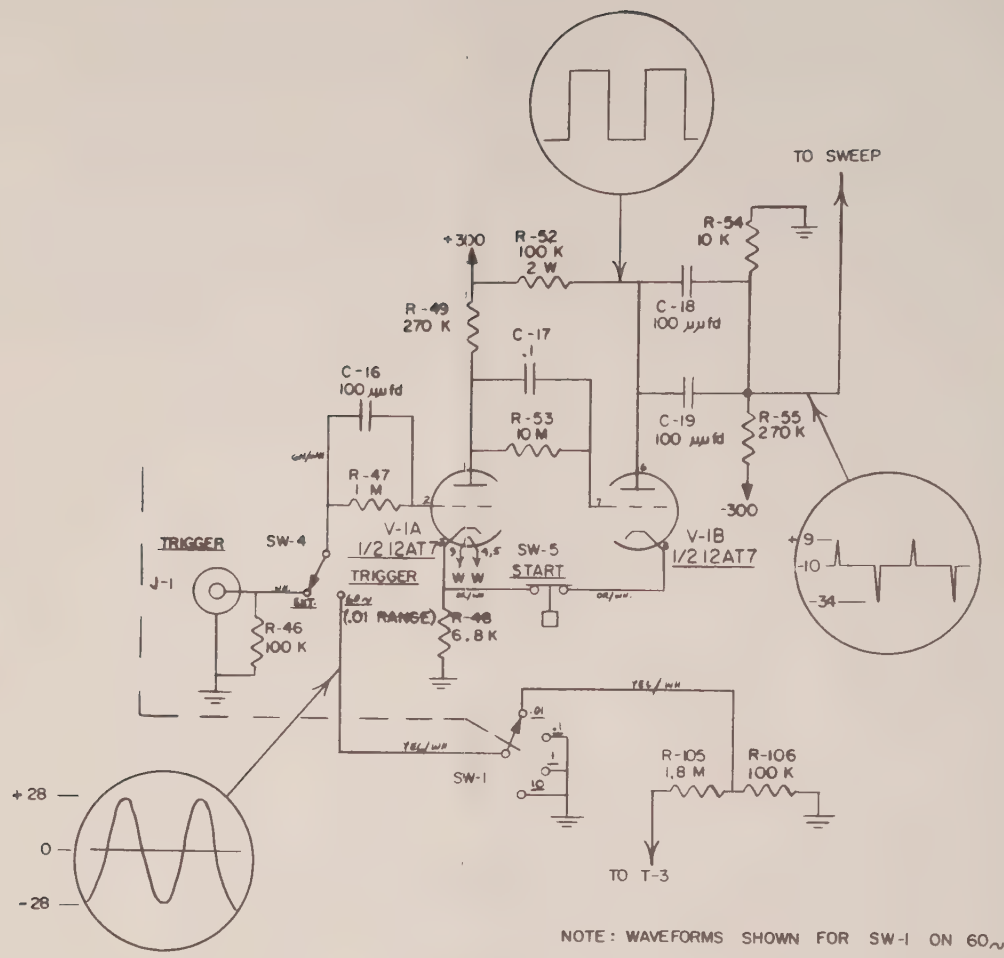
**Values depend on Model. Use schematics and BWO helix versus frequency curve in arriving at correct values.

***Or less depending upon helix voltage.



NOTE: WAVEFORMS TAKEN WITH SWEEP SWITCH SW-4 ON RECUR.

FIGURE 4-3
SWEEP GENERATOR



NOTE: WAVEFORMS SHOWN FOR SW-1 ON 60~.
10 MEG SCOPE INPUT.

FIGURE 4-4
SCHMITT TRIGGER

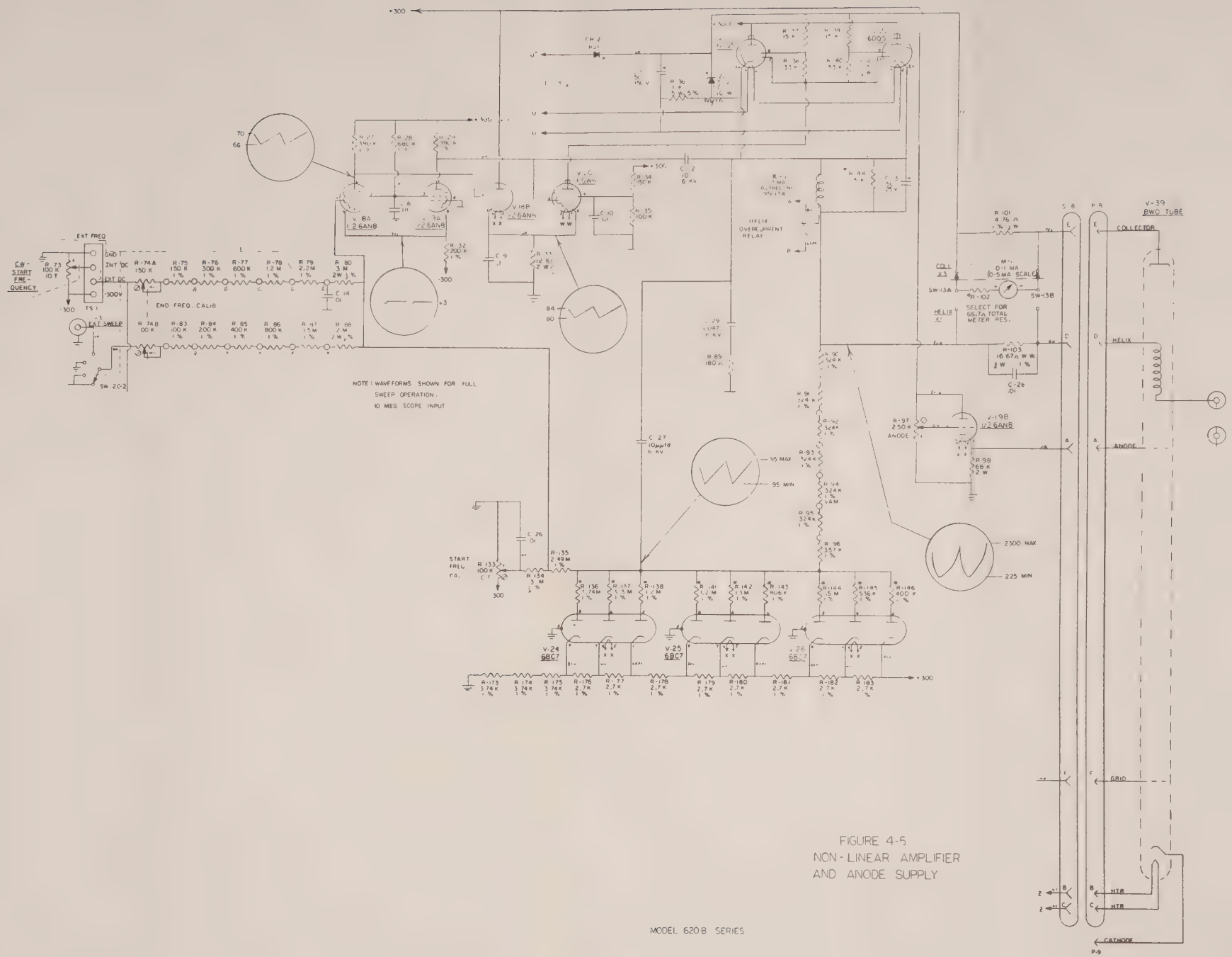


FIGURE 4-5
NON-LINEAR AMPLIFIER
AND ANODE SUPPLY

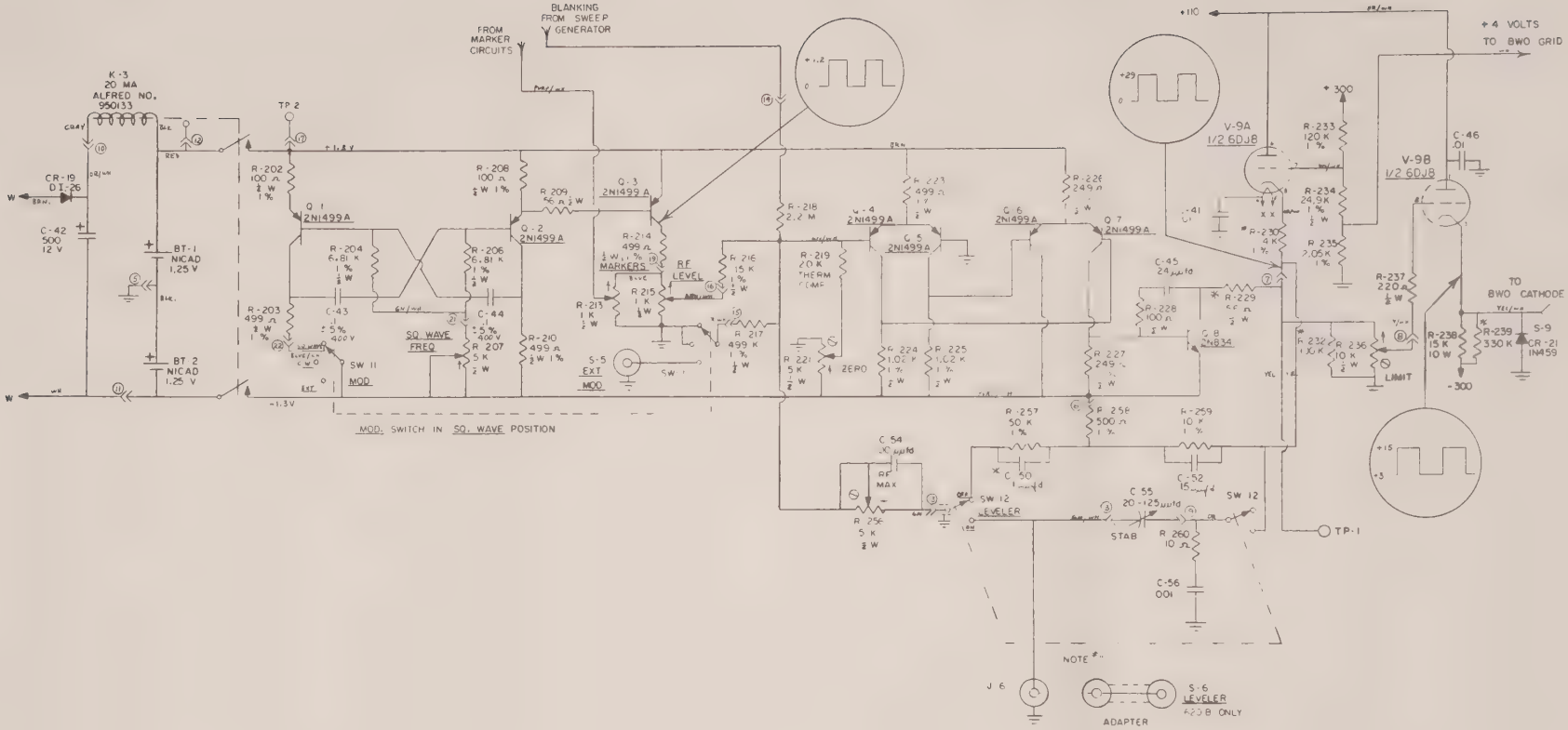


FIGURE 4-6
LEVELER

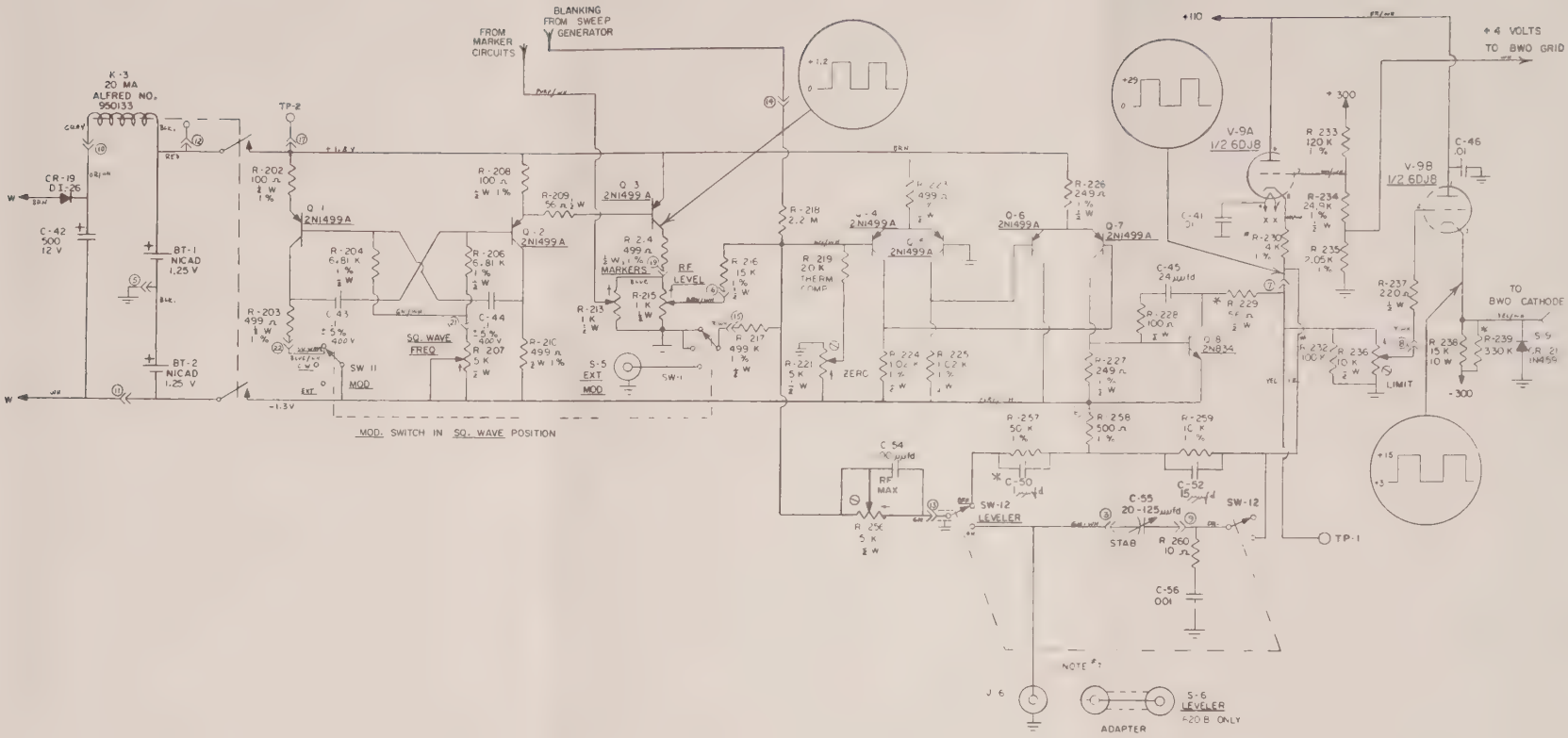
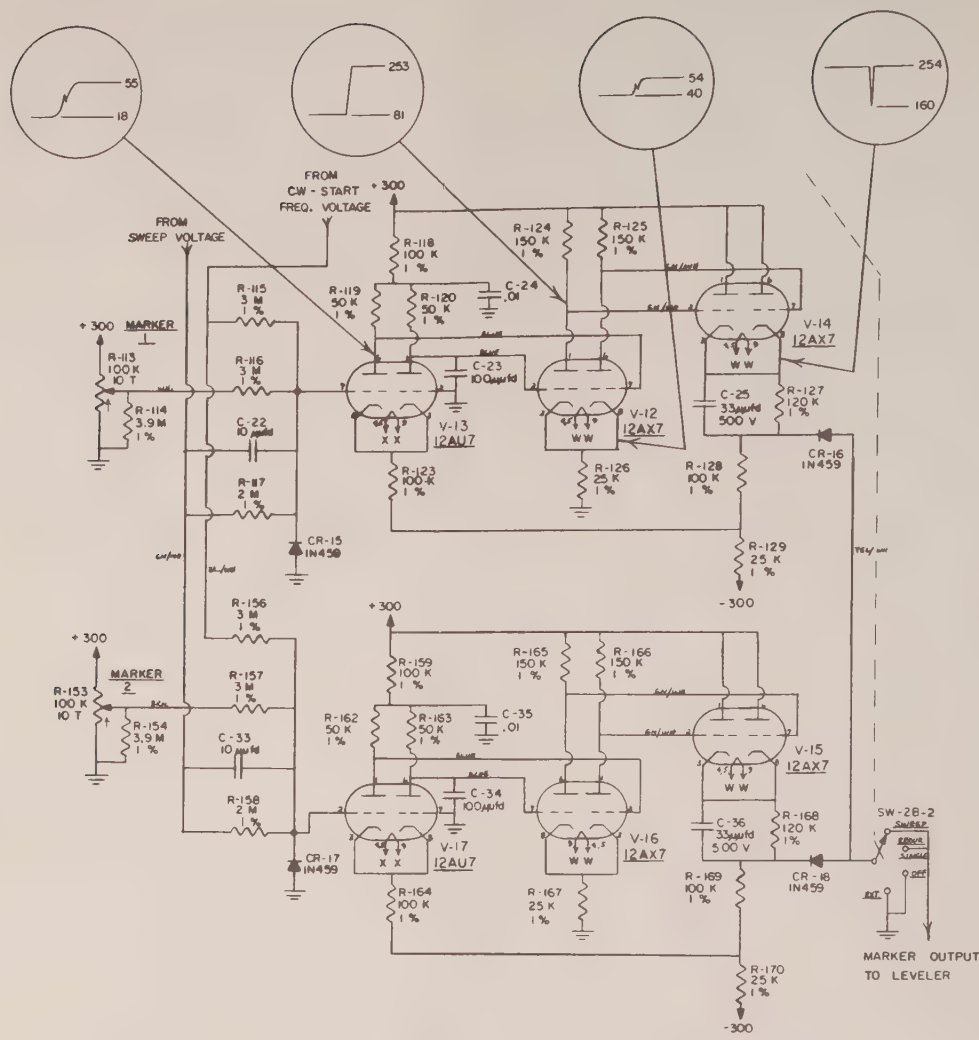


FIGURE 4-6
LEVELER



NOTE: WAVEFORMS TAKEN WITH CW-START FREQUENCY SET AT LOWEST FREQUENCY AND END FREQUENCY AT MAXIMUM.
MARKER 1 POT R-87 SET AT APPROX. MID-SCALE AND SWEEP SWITCH SW-4 ON RECUR. 10 MEG SCOPE INPUT

FIGURE 4-7
MARKERS CIRCUIT

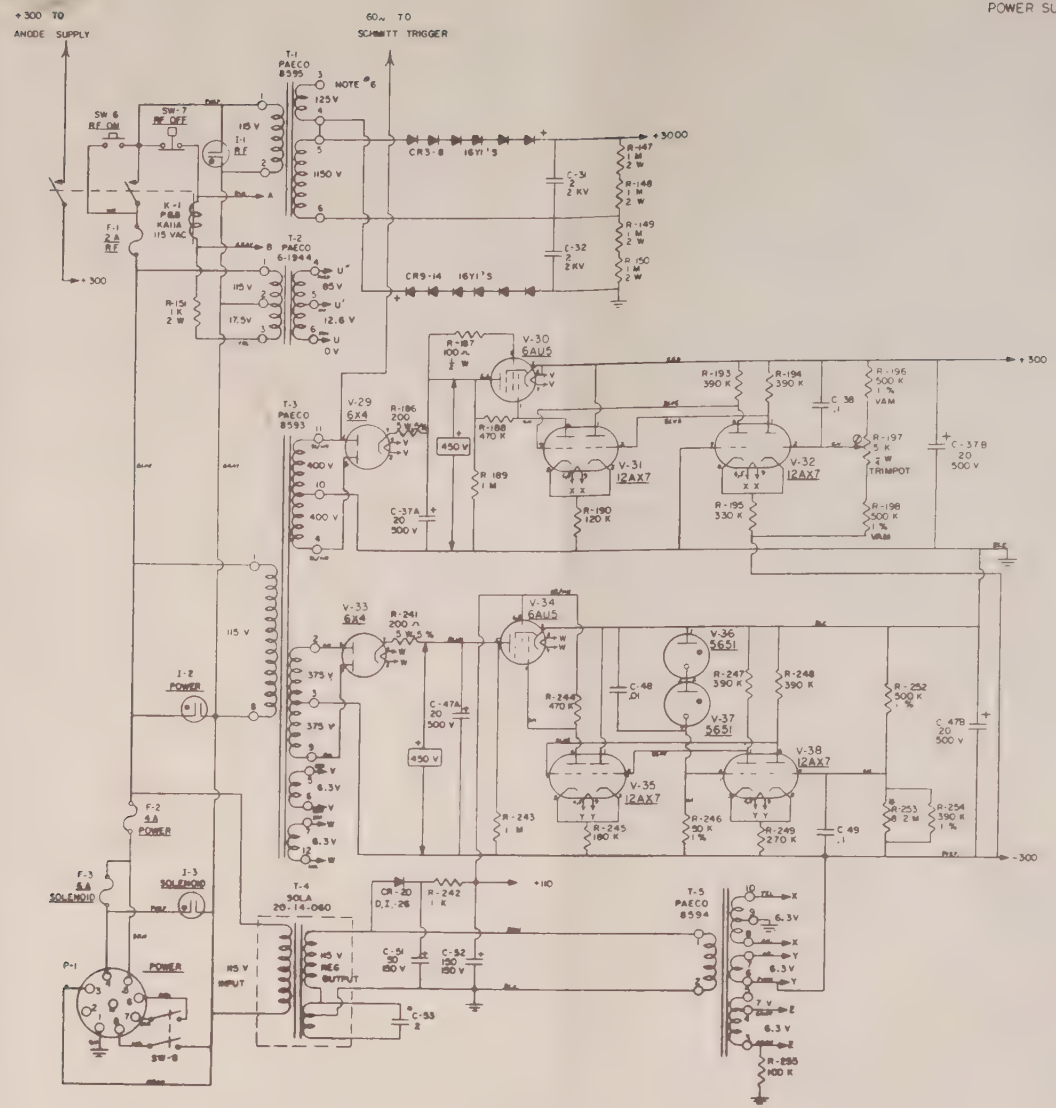


FIGURE 4-8
POWER SUPPLIES

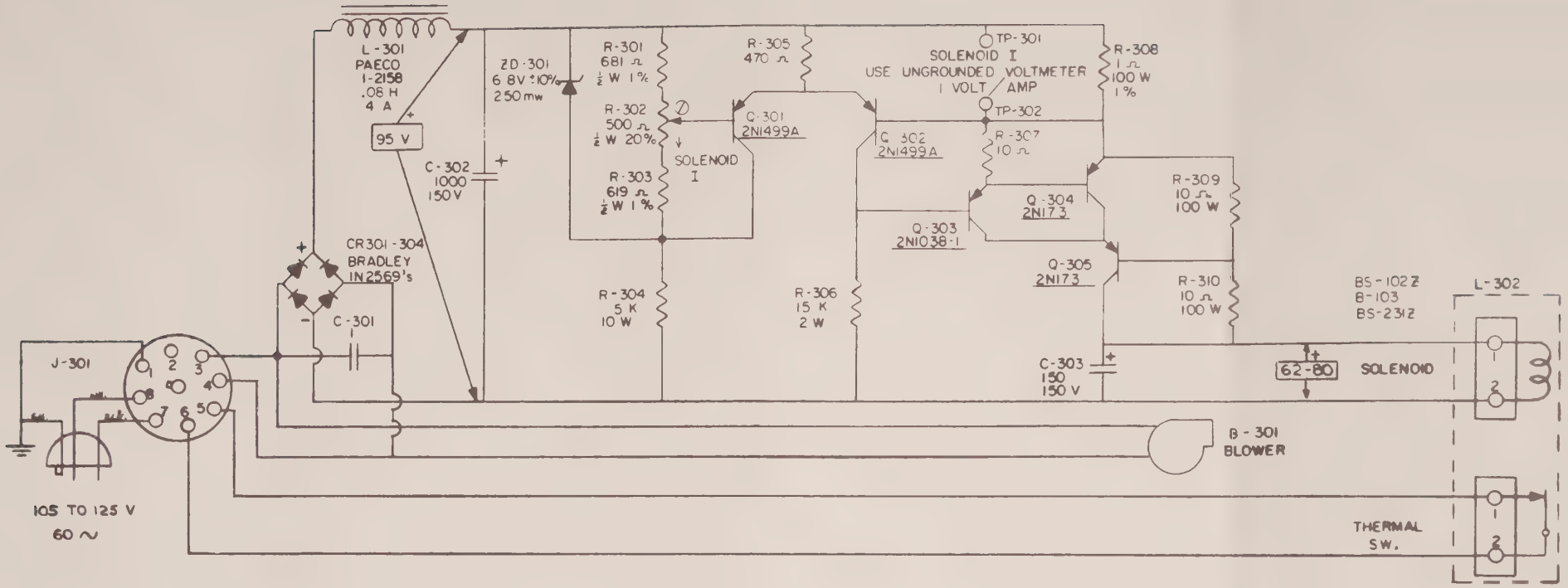
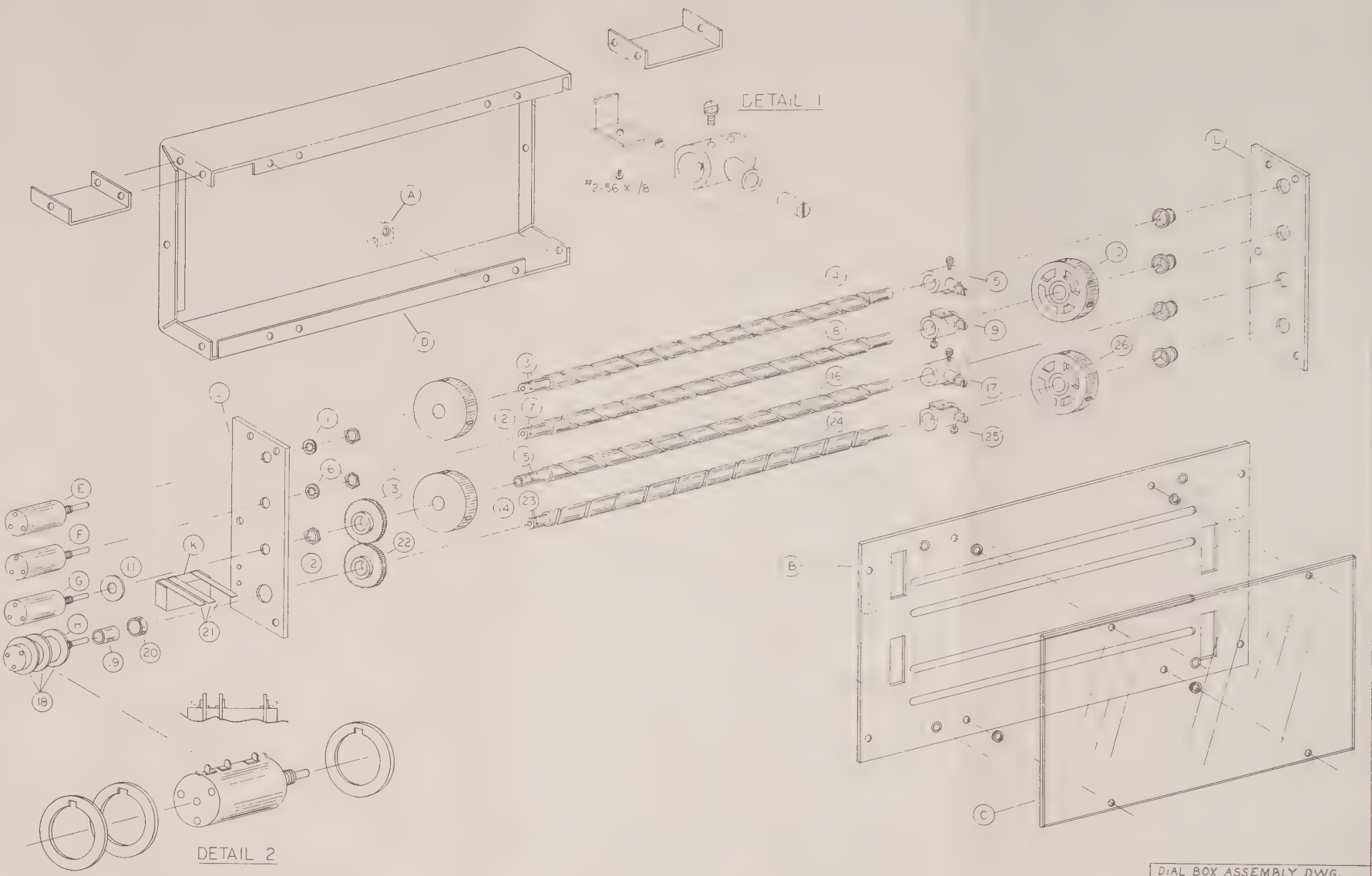


FIG. 4-9
SOLENOID SUPPLY



DIAL BOX ASSEMBLY DWG. 620B SERIES 990051 C			
ALFRED ELECTRONICS 827 COMMERCIAL STREET PALO ALTO, CALIFORNIA			
DRAWN R.F.H.	CHECKED E.C.R.	APPR'D L.F.D.	12/9/59

FIGURE 4-10

ELECTRODE SUPPLY CHASSIS
BOTTOM VIEW

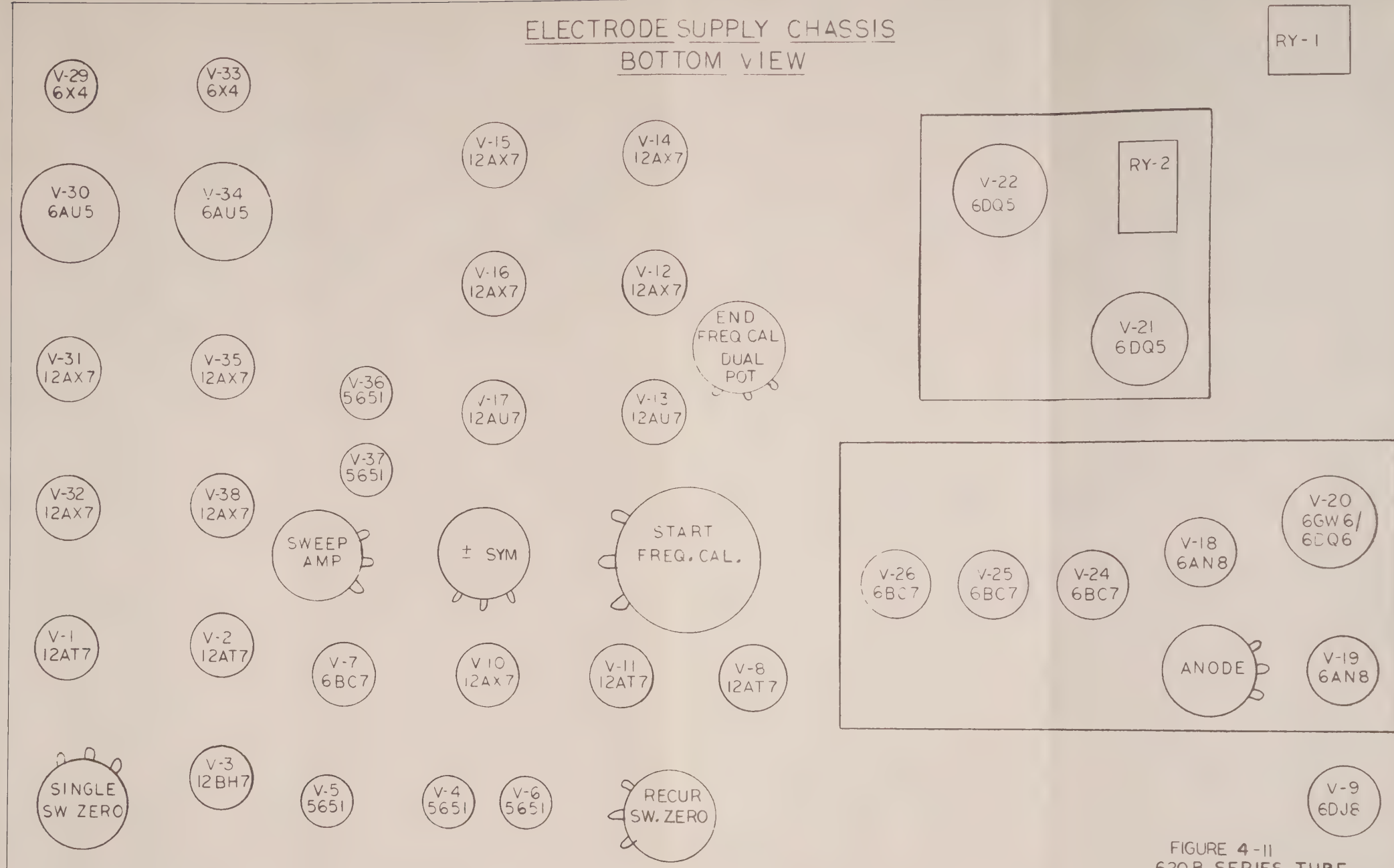
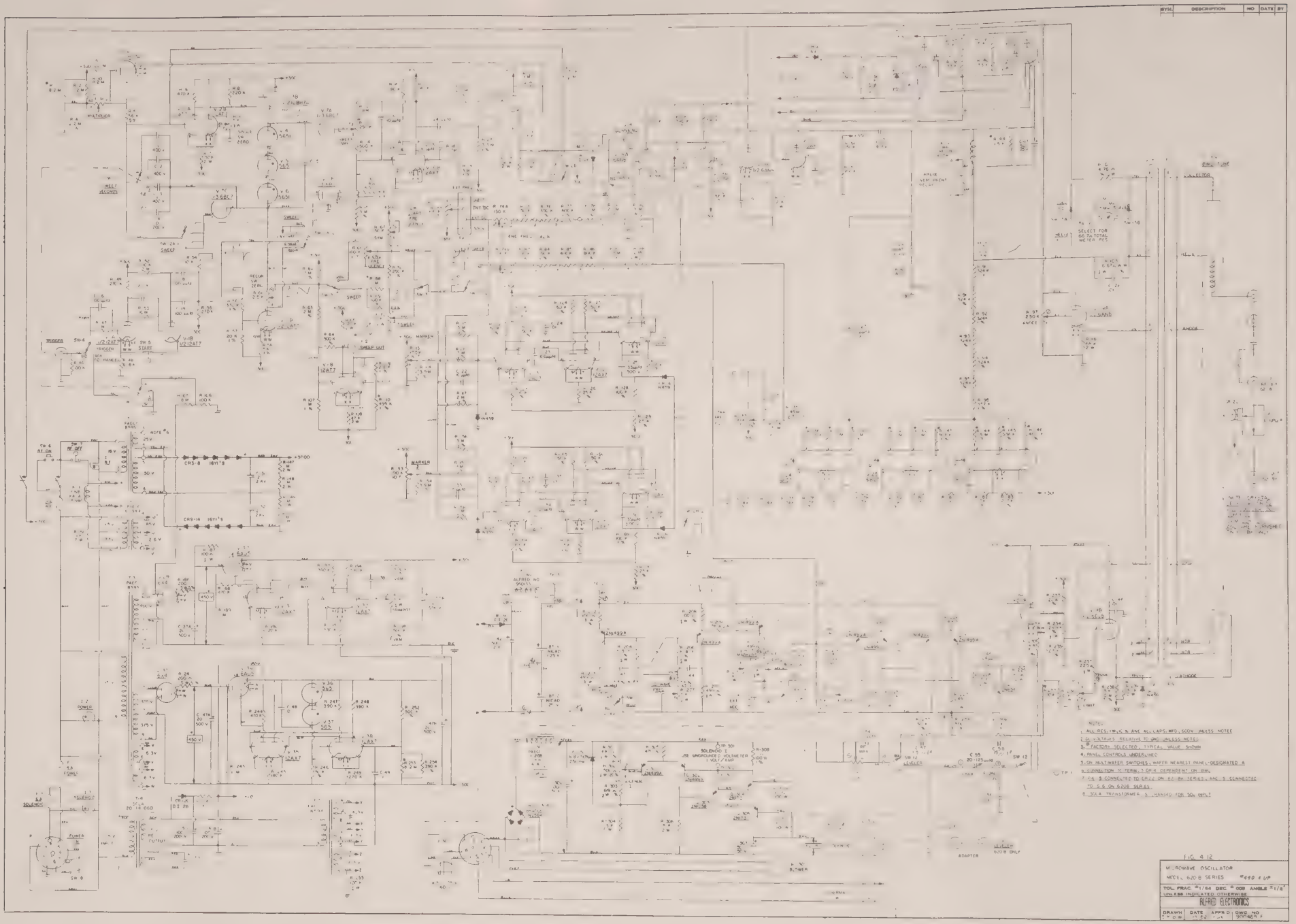


FIGURE 4-11
620B SERIES TUBE
LOCATION CHART


SYM
DESCRIPTION
NO
DATE
BY
NOTES:
1. ALL RES. 1/4W & ANY ALL CAPS MFD. 600V UNLESS NOTED
2. DC VOLTAGES NEGATIVE TO GND UNLESS NOTED
3. * FACTORY SELECTED, TYPICAL VALUE SHOWN
4. PANEL CONTROLS UNDERLINED
5. ON MULTIWAFER SWITCHES, WAFER NEAREST PANEL DESIGNATED A
6. CONNECTION TO TERM. 5 OPEN DEPENDENT ON S/N
7. FOR 5 CONNECTED TO GND ON 620 B/H SERIES; AND 5 CONNECTED TO 6 ON 620B SERIES
8. SCA TRANSFORMER 5 CHANGED FOR 50% INPUT
SOLENOID 1
SEE UNGROUNDED VOLTMETER 1 VOLT/AMP
SELECT FOR 66.7% TOTAL METER DEF.
ADAPTER
620B ONLY
FIG. 4.12
MICROWAVE OSCILLATOR
MODEL 620B SERIES *490 & UP
TOL. FRAC. ±1/64 DEC. ±.005 ANGLE ±1/2°
UNLESS INDICATED OTHERWISE
HEWLETT-PACKARD ELECTRONICS
DRAWN
DATE
APPR'D
DWG NO.
SHEET 4-2

MICROWAVE OSCILLATOR
MODEL 62__B/K, Serial No. ____

BWO HEATER (S-8, Pins B + C) (1 - 2)

E (6.0 - 6.6) V @ 103 V input, 1.0 A load Reg. @ 103 - 127 V line (<0.12) V

INTERNAL SUPPLIES @ 115 V

-300 V set Ripple (<3) mv pk to pk (1 - 3)

+300 V (set within ± 2 V of -300) Ripple (<3) mv pk to pk (1 - 4)

+1.30 V Ripple (<3) mv pk to pk

-1.30 V Ripple (<3) mv pk to pk

SWEEP GENERATOR (1 - 5)

Sweeps at all speeds on RECUR

60 TRIGGER operative @ .01 SECONDS on SINGLE

60 TRIGGER inoperative @ other sweep speeds and on RECUR

SINGLE SWEEP TRIGGER (int.) START (EXT) TRIGGER

RECUR SW ZERO set @ .1 SEC SWEEP SINGLE SW ZERO set

Sawtooth @ blue lead on SWEEP (toggle) sw (199- 201) V pk to pk (switch on DIAL)

Sawtooth @ red lead on SWEEP (toggle) sw (20 - 21) V pk to pk (switch on ± SWEEP)

SYM control set

DC voltage @ SWEEP OUT jack (< ± 1) V (EXT SWEEP) (1 - 6)

Noise @ SWEEP OUT jack (<25) mv pk to pk (MOD sw on SQ WAVE, EXT SWEEP)

Sawtooth @ SWEEP OUT jack (45 - 50) V pk to pk (RECUR SWEEP)

BLANKING (>75) V (1 - 7)

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SWEEP TIME (1 - 7)

.01 x 1 (.0095 - .0105) SEC.

.1 x 1 (.095 - .105) SEC.

1 x 1 (.95 - 1.05) SEC.

10 x 1 (9.5 - 10.5) SEC.

.01 x 10 (.095 - .105) SEC.

.1 x 10 (.95 - 1.05) SEC.

1 x 10 (9.5 - 10.5) SEC.

10 x 10 (95 - 105) SEC.

GRID (S-8, Pin F) (1 - 8)

E (3.8 - 4.3) V

CATHODE (Pos. S-9, Neg. chassis) LEVELER OFF (1 - 10)

Set leveler amplifier adjustment

1) LIMIT to full CW
2) ZERO to min E with RF LEVEL at 4 o'clock
3) RF MAX to mechanical center

RF LEVEL control at MAX, 0 load E_o (< E grid) Ripple (< 10) mv pk to pk

RF LEVEL control at MAX, 17 ma load E_o (<E grid) Ripple (<10) mv pk to pk

Noise @ 5 V output Ripple (<50) mv pk to pk

RF LEVEL control at MIN, 0 load E_o (>29)V Ripple (<10) mv pk to pk

Internal square wave (> 1.25) ms min. to (< .83) ms max.

SQ WAVE @ 1000 CPS $\frac{\text{on time}}{\text{off time}}$ (.95 - 1.05) rise time (≤1) microsec. fall time (<1) microsec. RF Level @ 3 o'clock

EXT MOD (-20 V square wave)

Blanking (>25) V pk to pk (RETRACE OFF)

MARKERS balance (within .5 V of each other) (RETRACE ON) RF LEVEL @ 3 o'clock

MARKERS MIN (0) V MAX (>5) V Width (<.5% total sweep width)

Phase shift between .01 - .1 SEC SWEEP (<1% total sweep width)

MARKER VS. CW CALIBRATION (Sweep @ .1 SECONDS)

CW START	MARKER 1	MARKER 2
Min.	(± .5) div.	(± .5) div.
Max.	(± 1) div.	(± 1) div.

END FREQ. (CW-START @ Min.)

Max.	(± 1) div.	(± 1) div.

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HELIX (Pos. S-8, Pin D, Neg. chassis) (2 - 2, 3 - 1, 4 - 1)

START FREQ. CAL. pot set @ 225 V	All ripple measurements pk to pk SQ WAVE OFF	SQ WAVE ON
Ripple @ 225 V, 0 load	(<50) mv	(<60) mv
Ripple @ 225 V, 17ma load(Hel = 2, Col = 15)	(<50) mv	(<60) mv (3 - 3)
Helix Max. E (>2300) V	END FREQ. CALIB. pot @ max.	
Ripple @ 2250 V, 0 load (3-6, 4-1)	(<150)mv	(<160) mv
Ripple @ 2250 V, 17 ma load (3 - 7)	(<150) mv	(<160) mv

E input min. @ 2250 V, 17 ma (<103) V

Meter @ 15 ma (14.7 - 15.3) ma (2 - 3, 3 - 7)

Meter @ 3 ma (2.9 - 3.1) ma (3 - 10, 4 - 5)

Helix overcurrent relay trips @ (3.2 - 3.7) ma (@ 2250) V

Reg. @ 225 V, 0 load, 103 - 127 V line (<50) mv (2 - 2, 3 - 4, 4 - 1)

Reg. @ 225 V, 17 ma load, 103 - 127 V line (<50) mv (3 - 3)

Reg. @ 225 V, 17 ma load, 115 V line (<65) mv

Reg. @ 1028 V, 0 load, 103 - 127 V line (<200) mv

Reg. @ 1028 V, 17 ma load, 103- 127 V line (<200) mv

Reg. @ 1028 V, 0 - 17 ma load, 115 V line (<200) mv

COLLECTOR (Pos. S-8, Pin E, Neg. Pin D) (2 - 4, 3 - A)

E_o (46 - 56) V @ 15 ma Ripple (<200) mv pk to pk

ANODE SUPPLY (Pos. S-8, Pin A, Neg. chassis) (1-11, 2 - 1, 3 - 1)

E min. (<30) V @ .1 ma load Ripple (<5) mv pk to pk

E max. (>295) V @ 1 ma load Ripple (<5) mv pk to pk

Noise @ 150 V output (<60) mv pk to pk (SWEEP @ .01 SEC.)

INTERNAL SWEEP (2 - 2)

E_o sweeps within (± 2) % Helix Max E

EXTERNAL SWEEP

E_o sweeps to within (± 2) % Helix Max E @ -200 V input

HELIX VOLTAGE DRIFT @ 1028 V

3rd hour (<0.9) V

Calibration Engineer _____

Date _____

MODEL 620 B/K, Serial No. ___

SOLENOID

I set to 3.75A

Ripple 0.04 v pk to pk
(<0.2)

Reg. 105 - 125 V line <.08A

4-11-62

MODEL 6258/K
Serial No. 513

RF TEST

Tube Model # 111-12018 H
Serial # 111 131

Solenoid Model # B1037
Serial # 37

LIMIT set OK ✓ Output greater than 10 mw across the band OK ✓

Dial	Limits	CW Start Freq.	Markers 1	Markers 2	Δ f P max to P min	Helix I	Coll. I
12.4	(12.256-12.524)	12.404	12.380	12.392	.008	1.3	3.3
13.0	(12.870-13.130)	13.014	12.988	13.000			
13.5	(13.365-13.635)	13.559	13.542	13.556			
14.0	(13.860-14.140)	14.039	14.022	14.032			
14.5	(14.355-14.645)	14.556	14.535	14.550			
15.0	(14.850-15.150)	15.079	15.055	15.072	.025	1.3	3.3
15.5	(15.345-15.655)	15.547	15.528	15.544			
16.0	(15.840-16.160)	16.032	16.014	16.026			
16.5	(16.335-16.665)	16.480	16.460	16.479			
17.0	(16.830-17.170)	16.925	16.942	16.960			
17.5	(17.325-17.675)	17.414	17.450	17.460			
18.0	(17.820-18.180)	17.990	17.945	17.946	.023	1.65	3.4

START FREQ. CALIB. pot. lock nut tightened OK ✓

SINGLE SWEEP ZERO set OK ✓ @ 12.4 Gc — Lock nut tightened OK ✓

RECUR SWEEP ZERO set OK ✓ @ 12.4 Gc — Lock nut tightened OK ✓

SWEEP AMPLITUDE OK ✓ @ 18 Gc — Lock nut tightened OK ✓

Helix Voltage Range 580 v to 970 v — Tube Locked Down OK ✓

LEVELER ADJUSTMENT

STAB. set OK ✓ (Min. sq. wave rise time)

RF MAX @ Mechanical Center — Leveled Operation OK ✓

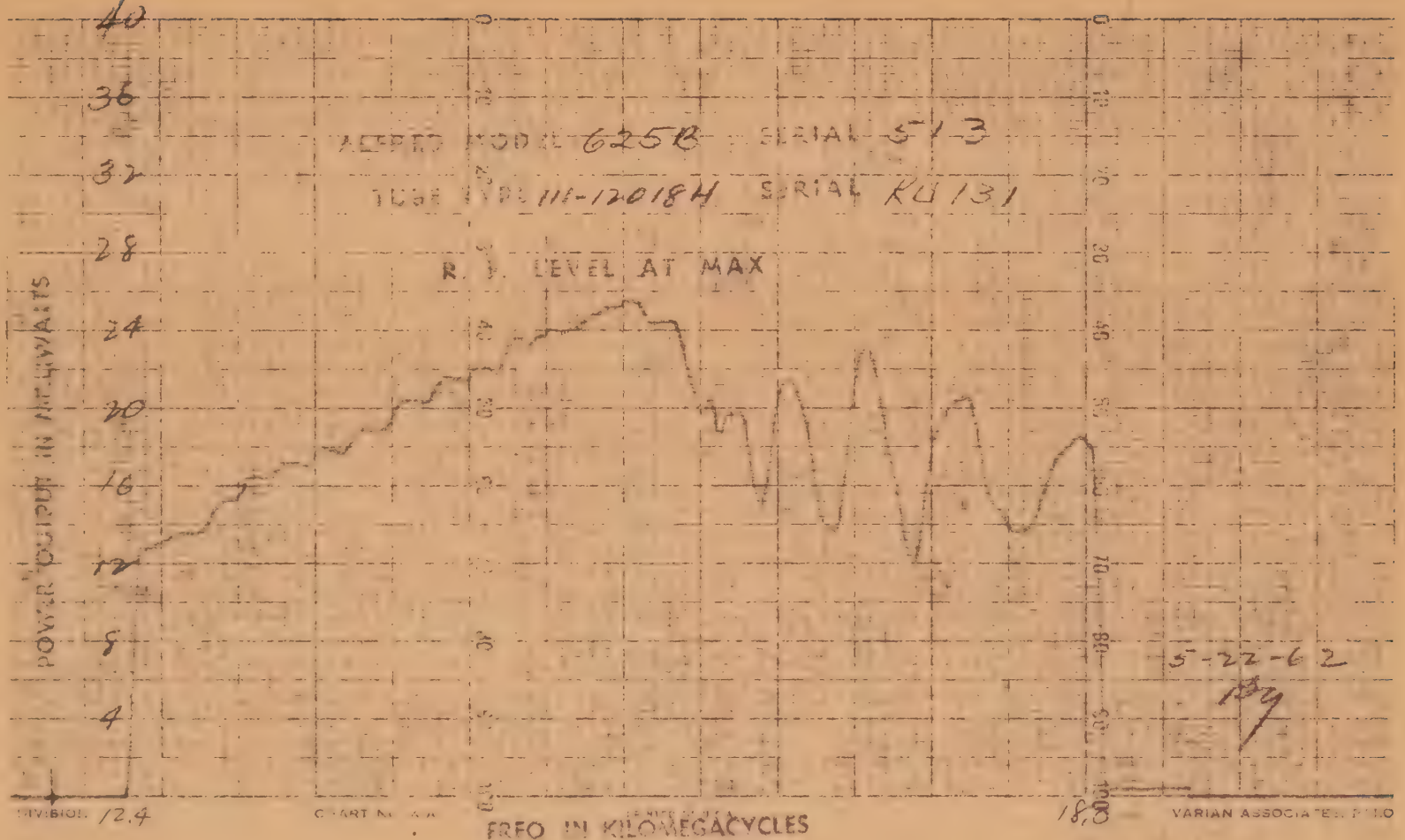
R136 3.74 M	R142 1.3 M	R145 0.4 M	
R137 3.3	R143 0.806	R_{in} 3.25	R75 through R79
R138 1.2	R144 1.5	R_{fb} 2.301	R90 through R96
R141 1.2	R145 0.536		

CW FM <350 KC ✓ OK SQ. WAVE FM <[illegible] in 500μs OK ✓

Calibration Engineer [signature] Final Elec. Insp. [signature] Final Mech. Insp. [signature]

Date 5-2-62 Date 5-2-62 Date 5-2-62

0-62


AEPRO MODEL 6250 SERIAL 513
TUBE TYPE III-120184 SERIAL KU 131
R. F. LEVEL AT MAX
POWER OUTPUT IN MILLIWATTS
40
36
32
28
24
20
16
12
8
4
5-22-62
FREQ IN KILOMEGACYCLES
12.4
18,0
VARIAN ASSOCIATES

STEWART
ENGINEERING COMPANY
SANTA CRUZ • CALIFORNIA

Conditions of Warranty

Backward-wave oscillators manufactured by Stewart Engineering Company are warranted to be free from manufacturing defects for a period of one year from date of purchase (plus shelf life, if any, as stipulated below) or five hundred (500) hours of heater filament operating time.

If the tube should fail during the warranty period as a result of a defect in manufacture, it must be returned to the factory (note procedure on reverse side). The manufacturer reserves the right to repair the tube, and return it to the customer. Tubes received broken or with evidence of tampering do not qualify. Unrepairable tubes will be replaced as follows:

1. Replacement will be made at no cost if failure occurs within the first 50 hours of heater filament operation, or two (2) months of operation, whichever is the lesser period.

2. After this initial two-month/50-hour period tubes will be replaced at a prorated cost. The actual amount will be determined on the basis of months remaining in the one-year warranty period, or the hours remaining in the warranted heater filament operating time, whichever is the lesser credit.

3. A credit allowance of $20.00 against purchases may be allowed for the return of a complete tube in its capsule and with cables, regardless of the age of the tube. The tube and accessories must be in good physical condition to qualify for this credit.

Shelf Life Provision

On written application, Stewart Engineering Company will grant OEM's and other Stewart customers a maximum additional warranty period of six months for shelf life of tubes awaiting installation.

STEWART
ENGINEERING COMPANY
SANTA CRUZ • CALIFORNIA

Service Information

IMPORTANT: Please answer ALL questions fully — insufficient information may delay processing of your claim. Note tube return procedure on reverse side.

FROM: (Tube Owner)

Company_____

Address_____

_____

_____

Tube Type_____

Tube Serial No._____

Tube Purchased From_____

Tube is Original ( ) or Replacement ( )

FOR FURTHER INFORMATION CONTACT:

Name_____

Title_____

Company_____

Address_____

_____

Equipment Manufacturer_____

Equipment Model_____

Equipment Purchase Date_____

Tube Return Procedure

No allowance will be made for returned tubes which are broken on arrival at the factory. Tubes must be packed and shipped according to the instructions below and the Service Information form must be properly completed and included in the tube carton.

1. Carefully wrap tube in ¼ inch thick "kimpack" cotton batting, or other soft padding material.

2. Wrap the above in heavy kraft paper.

3. Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.

4. Surround the tube with at least 2 inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.

5. Tubes returned from outside the continental United States should be packed in a wooden box.

6. Mark container FRAGILE and ship prepaid via Air Freight or Railway Express to address shown at the top of the page. Do not ship via Parcel Post or Air Parcel Post since experience has shown that fragile items are more apt to be damaged when shipped by these means.

Service Information (Cont'd.)

Date Tube Received _____

Date First Tested _____

Date Placed in Service _____

Date of Failure _____

Hours Use Per Day (Average) _____

Number of Days in Service _____

Total Hours Filament Operation _____

_____

1. SYMPTOMS: (Description of tube's defect, if known) _____

_____

_____

2. OPERATING CONDITIONS AT TIME OF FAILURE (Be sure to indicate any unusual conditions) _____

_____

_____

_____

Signature _____

Title _____

Date _____

FELTON The Village Print Shop CALIFORNIA

SHIPMENT DAMAGE CLAIM

The instrument should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim must be filed with the carrier. Have carrier agent inspect damage to instrument and packing crate and forward to us a copy of his written report. You will then be advised of replacement or repair arrangements and disposition of the equipment. Please include model number, type number and serial number when referring to this instrument for any reason.

WARRANTY

ALFRED ELECTRONICS warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and the replacing of any defective parts. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and which upon our examination is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case an estimate will be submitted before the work is started.

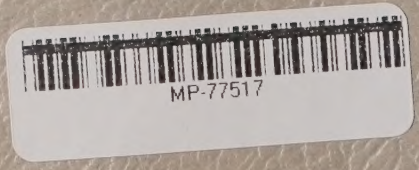
If any fault develops:

1. Notify us, giving full details of the difficulty, including the model number, type number and serial number. Upon receipt of this information you will be sent service instructions or shipping data.

2. Upon receipt of shipping instructions forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins when instrument is not covered by this warranty.

PACKING

The instrument should be packed in the original carton. If unusable or not available, use a wooden box with approximately three inches of excelsior or other shock-absorbing material surrounding the instrument. If desired, packing services of a local Transfer and Storage company may be employed.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